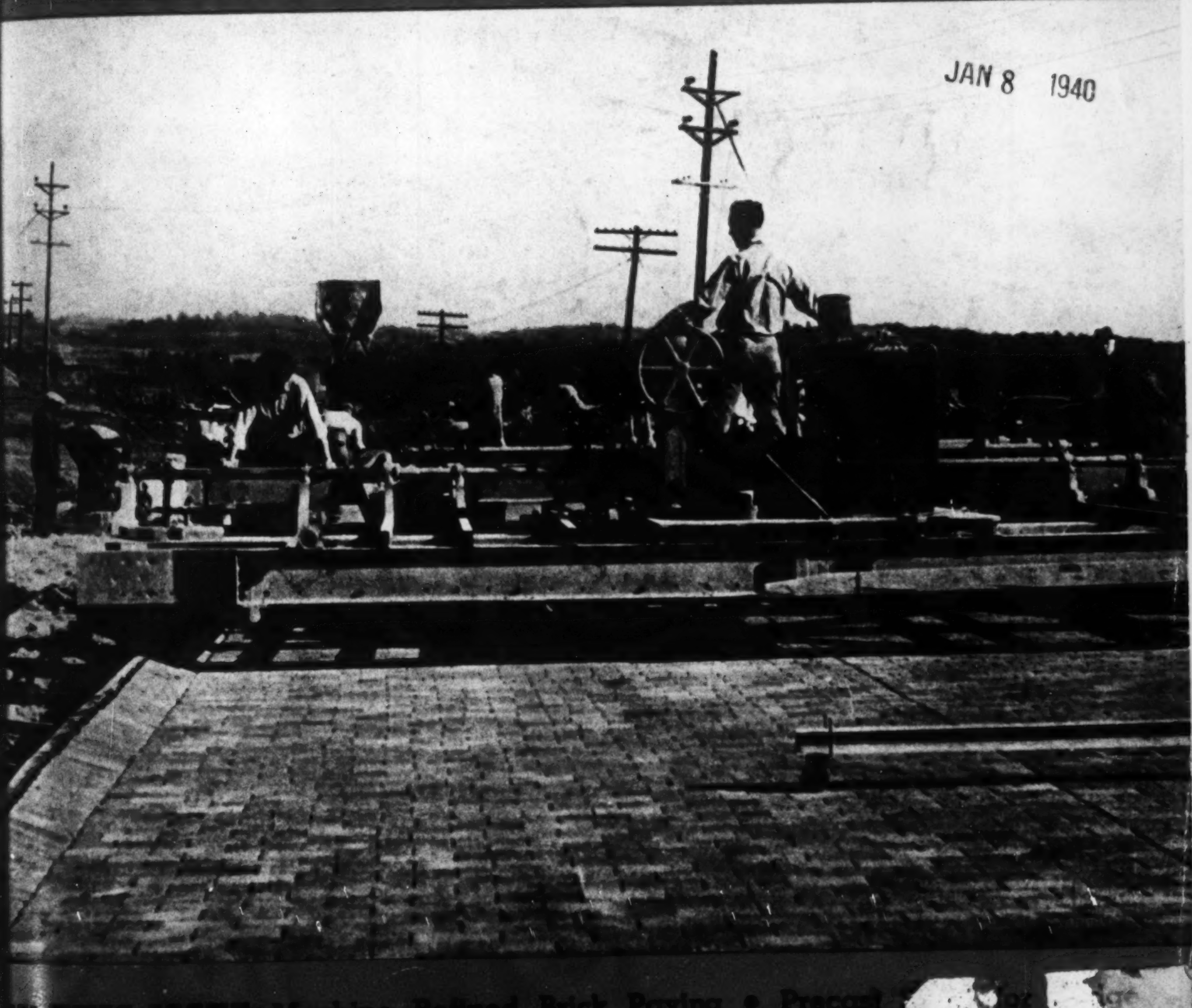
THE ENGINEERING CONSTRUCTION WEEKLY

ENGINEERING NEWS-RECORD

JANUARY 4, 1940

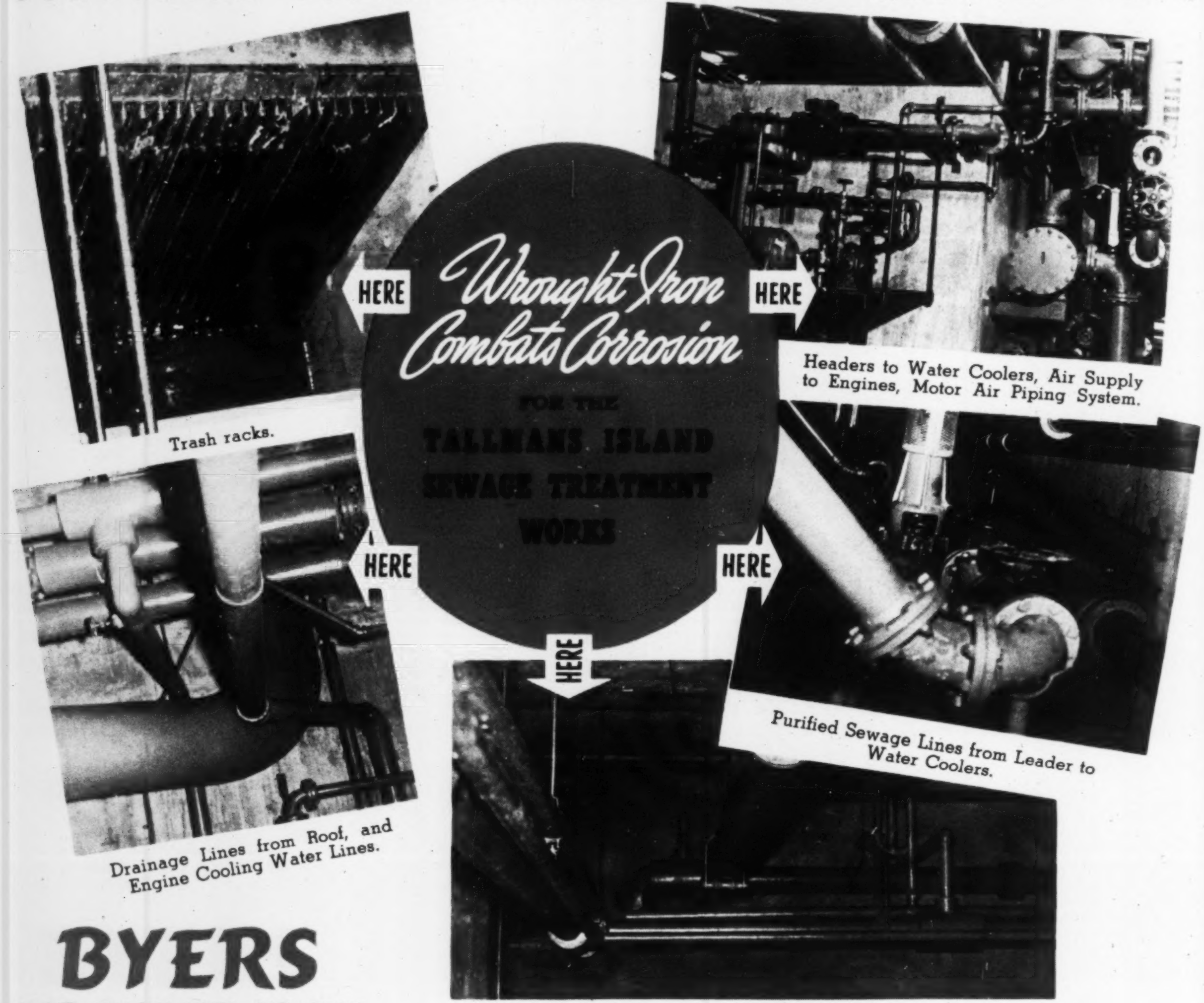
surfaced road in Stark County, Ohio, after vibrating and before grouting.



JAN 8 1940

IN THIS ISSUE: Machine Refined Brick Paving • Precast [illegible] for [illegible]ge Abutments • Wire Rope Economy • Lake Water for Toledo [illegible] Fast Erec[illegible] of uilding Trusses • Midtown Tunnel Driving • For Full Conte[illegible] See Page 21.

CORROSION COSTS YOU MORE THAN WROUGHT IRON


HERE
Wrought Iron Combats Corrosion
FOR THE TALLMANS ISLAND SEWAGE TREATMENT WORKS
HERE
HERE
HERE
HERE

Trash racks.

Headers to Water Coolers, Air Supply to Engines, Motor Air Piping System.

Drainage Lines from Roof, and Engine Cooling Water Lines.

Purified Sewage Lines from Leader to Water Coolers.

Cold Water Lines (1½" and over). Also entire Hot Water Heating System and Soil, Waste, and Vent Lines above Ground.

BYERS WROUGHT IRON

The wide variety of corrosive services in the modern sewage plant, plus the need for maximum life and minimum maintenance, make proper material selection second in importance only to the design of the plant itself. The care with which designers approach this problem is well illustrated by the piping specifications for the Tallmans Island Sewage Treatment Works. It is the third project in a contemplated program of about 30 plants, cost over $4,000,000 and was built by the Department of Public Works of New York City. Wrought iron was used in a number of services, listed above.

Wrought iron has been used for highly corrosive services in practically all modern treatment plants . . . and there's a reason. Designers recognize that sewage is an active corrosive material, whose handling demands the same judgment that the chemical industry devotes to its destructive products.

They recognize that past experience under actual operating conditions is the only completely reliable guide in selecting materials to meet these conditions. Wrought iron has been used in the handling and treatment of sewage over a long period of years. The service records provide a safe and sound basis for present day selection.

If you have some corrosion problem in any process, heating or plumbing lines, wrought iron may prove an equally economical solution. If you will write, giving details, our Engineering Service Department will (1) Determine the probable corrosive conditions; (2) Relate these to similar conditions encountered elsewhere; (3) interpret the findings in the light of 76 years' experience with corrosion problems; and (4) Make recommendations . . . supported by service records. Ask, too, for a copy of our bulletin, "Wrought Iron in Sanitary Systems."

A. M. Byers Co., Pittsburgh, Pa. Established 1864. Boston, New York, Philadelphia, Washington, Chicago, St. Louis, Houston, Seattle, San Francisco.

BYERS GENUINE WROUGHT IRON
TUBULAR AND FLAT ROLLED PRODUCTS
Specify Byers Genuine Wrought Iron Pipe for corrosive services and Byers Steel Pipe for your other requirements

ENGINEERING NEWS-RECORD

Devoted to Buildings, Sewers, Waterworks, Bridges, Highways, Streets, Dams, Foundations, Earthwork, Flood Control, Public Works, Irrigation, Canals, Railroads

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THIS WEEK

- Ohio is continuing its research to produce a brick pavement that meets all the requirements of modern highway design. This issue reports on methods and machines developed for an experimental section built last year.

- The life of wire rope depends in large measure on the form of the sheaves and drums over which it is passed. A review of sheave characteristics that should be understood by all contractors who use wire rope is given on p. 39.

- Treated timber holds an important place in the decking of old bridges where dead load is an important factor. Designs used in the Morrison St. Bridge at Portland, Ore., are described on p. 44.

- The new Tiffany Building at New York is being built with large steel trusses spanning from wall to wall to give a show room 85 x 100 ft. without columns. The way in which designers and steel erection met the problem is given on p. 46.

- At Pueblo, Colo., the sewage disposal plant has been designed to take advantage of the fact that the Arkansas River, into which the effluent goes, is used for irrigation. Solids are removed and final treatment is by natural means in the irrigation systems.

- Municipal engineers will find valuable information in the account of how Miami handles the monumenting for its city survey work on p. 51.

- Contractors on the Queens-Midtown Tunnel went through the worst ground yet encountered in driving tunnels under the East River at New York. Their methods and equipment are described on p. 53. This article supplements one published in the December 21 issue.

- Toledo is going to Lake Erie for water after drawing from the polluted Maumee River for many years. Some of the unusual problems to be met are outlined on p. 59.

- Precast concrete slabs were used for bridge abutments on Merritt Parkway. As in building work, they give the bridge builders a new tool by which to obtain better and more attractive designs. Closely related are the experiments with form lining reported on p. 64.

ANNUAL HIGHWAY NUMBER

The War Department's objectives in plans to make our peacetime highways effective for national defense will be set forth in the January 18 issue. Also given will be the first statistical summary of road work in 1939 with estimates of what will be done this year.

387 tons of Ryerson New Billet Reinforcing Bars used for Sewerage Treatment Plant at Stevens Point, Wisconsin, by Foster-Morris Co., Milwaukee, Contractors.

Work Progresses "on schedule" with Ryerson Reinforcing

There's no waiting for steel when it is ordered from Ryerson. Thousands of contractors have learned by experience that Ryerson can be depended upon to accurately cut, bend, form, bundle, tag, and deliver bars, spirals, etc., at the time specified. Large stocks, experienced crews, complete cutting and forming equipment, and special dispatching methods assure delivery according to exact specifications . . . and on scheduled time.

You can save time, trouble and money by taking advantage of Ryerson's complete service which includes all accessories, wire mesh, caisson rings, removable forms and every miscellaneous steel requirement from structurals to sheets—foundation bolts to welding rod. Placing all your steel requirements with this one dependable source assures co-ordinated shipment of all material at the exact time specified.

Our special Contractors and Builders Division will be glad to work with you on your next job. Whether your problem is one of intricacy of design, large or small tonnage, special service, or limited time, a Ryerson engineer can probably save you time and money. Get in touch with the plant nearest you.

Joseph T. Ryerson & Son, Inc., Chicago, Milwaukee, St. Louis, Cincinnati, Detroit, Cleveland, Boston, Buffalo, Philadelphia, Jersey City.

RYERSON *for* REINFORCING

NEWS
ENGINEERING NEWS-RECORD
Volume 124 JANUARY 4, 1940 Number 1

New Highway Bill Studied by Congress

Would govern federal policy and expenditures for fiscal years 1941–42 and 1942–43

The highway authorization bill governing federal road policy for the fiscal years 1941–2 and 1942–3 was introduced into both houses of Congress simultaneously this week by Senator Hayden and Representative Cartwright. It is in two sections, the first section authorizing amounts, which are left blank, for continuation of regular federal aid to primary and secondary roads and grade crossing elimination as well as for construction of roads on federal lands.

For financing rights'-of-way

The second section introduces a new feature by incorporating, with slight changes, the right-of-way bill (*ENR*, Aug. 10, 1939, p. 190) introduced late last session. This section would aid in the financing and purchase of rights-of-way for highways, bridges and tunnels.

Intended primarily to encourage construction of express roads through congested areas where rights of way are difficult to acquire, the section would offer two forms of aid. RFC may make 40-year loans to states, cities or counties, at interest sufficient to reimburse the government, for the purchase of rights-of-way, or in cases in which debt limits cause difficulties or local condemnation laws are less effective than the federal law.

Federal condemnation planned

The PRA will buy the land and rent it to the local government at a rate which will reimburse it in 40 years. Federal condemnation law permits immediate taking of land without waiting for a court determination of price. No aid could be given to any city or county government without the consent of the state highway department.

Bachrach photo

NEW ENR EDITOR

WALDO G. BOWMAN, whose appointment as co-editor of *Engineering News-Record* is announced on the editorial page of this issue, has been a member of the editorial staff of the paper for nearly fifteen years, most recently as executive editor. A graduate in civil engineering of the University of Kansas, he supplemented his engineering training with work at the Harvard Graduate School of Business Administration. Previous to joining the staff of *Engineering News-Record* he worked for the Union Pacific R.R., the industrial commission and the state highway department of Kansas, the Chicago Bridge & Iron Co. and the Boston Bridge Works. Bowman is author of the section on construction equipment in Hool & Johnson's Handbook on Building Construction, and annually of the civil engineering review in the National Encyclopedia. He has written extensively on bridge, building, structural and research matters in *Engineering News-Record*. An associate member of the American Society of Civil Engineers, he has also been active in the American Concrete Institute and the American Welding Society.

1940 Road Allotments Announced by PRA

Total for 48 states, District of Columbia, Hawaii and Puerto Rico is $156,000,000

A total of $156,000,000 has been apportioned among the 48 states, the District of Columbia, Hawaii and Puerto Rico for highway improvements and the elimination of railroad grade crossing hazards for the fiscal year beginning July 1, 1940, according to announcement by John M. Carmody, Federal Works Administrator. The apportionment is made under the act of June 8, 1938, and the highway fund is divided among states in proportion to population, area, and mileage of rural post roads. The amount the various states got for grade crossing work de-

(Continued on page 27)

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H. P. Treadway Dies; Kansas City Contractor

Howard Platt Treadway, 65, president and treasurer of the Kansas City Bridge Co. until his retirement a year ago, died Dec. 25 in Kansas City.

Treadway was born at Spring Lake, Mich., Oct. 26, 1874. Following his graduation with a civil engineering degree from the University of Michigan in 1898, his first job was with the Old Dominion Copper Mine and Smelting Co., Globe, Ariz. He next worked at Kansas City, Mo. and Omaha, Nebr. as contracting engineer for the Wrought Iron Bridge Co. of Canton, Ohio. The following year was spent as contracting engineer at Omaha for the American Bridge Co., New York City.

In June 1902, he joined Kansas City Bridge as construction engineer to become president and treasurer in 1926 upon the death of Alexander Maitland. When he retired last year, he was succeeded by Fred R. Hoover.

Treadway was also president and a director of the Kansas City Crushed Stone Co. and director of the Shenandoah-Dives Mining Co.

MotorTruckConference Held in New York

Manufacturers, oil company representatives and operators meet for 5-day session

Nearly 400 fleet operators, oil company representatives and engine and equipment manufacturers spent five days in New York City in December discussing maintenance, operating and engineering problems that have a bearing on motor truck economy and efficiency. The meeting, sponsored by the fleet division of the Ethyl Gasoline Corp., was one of a series of regional conferences held during the year and dating back to an original meeting held in Detroit in 1938. Higher power-weight ratios and multi-speed transmissions were suggested as logical future developments for improving the operating economy of trucks and buses. It was disclosed that gasolines of a quality never before available to the general public at regular prices are now appearing on the market and that superfuels, such as those used in the past only in aviation, are now coming into the premium gasoline market. Future commercial engine development, proper maintenance and driver re-training for economy were among other subjects discussed.

Future engine development

Robert Cass, White Motor Co., in speaking of the future development of the commercial engine for truck and bus use, said that a lot depends upon the possibility of continuing the use of the Otto four-cycle, multi-cylinder engines; the two-cycle engine, despite its advantage of small size, will not be a major factor. Cass stated that his company believed that the number of cylinders can be restricted to six and twelve in the gasoline engine and six in the diesel.

That the diesel engine will also continue to develop largely along the four-cycle type, and that the use of the diesel in general will expand only so long as the present favorable fuel cost conditions exist, were other views expressed by Cass. The diesel engine will be handicapped as compared to the future gasoline engine due to the diesel's first cost and weight, it was stated. That the successful gasoline engine of the future in the bus and truck field will have a decided reduced weight per horsepower was another view expressed. According to Cass, engines are already being produced that are several pounds per horsepower lighter than eighteen months ago. Notable reductions have taken place in road load gasoline consumption to the point of increasing it from 75 to 80 ton-miles per gallon to 120 to 130 ton-miles per gallon, Cass stated.

Future motor truck

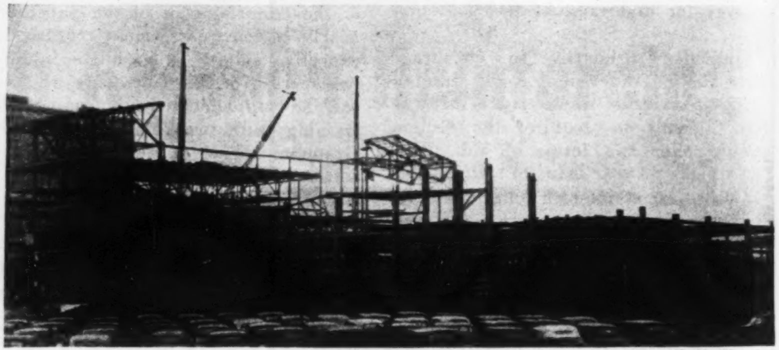
"How Motor Trucks May Develop" was discussed by D. C. Fenner and M. C. Horine, of Mack International. State legislative restrictions, they pointed out, may influence truck design more than we might realize. For example, the restrictions in Texas of limiting loads to a payload of 3½ tons unless hauling to or from a railroad, was mentioned as influencing truck design not only in Texas but in adjoining states. How the Illinois length limitation has required the building of special foreshortened equipment for that state was another example cited.

Trend of motor truck styles will depend largely upon legislative restrictions. Though tractor semi-trailers have a place in motor haulage, the six-wheel trucks and four-wheel full trailers will probably be preferred in the future, the two men believe, because they are more susceptible to engineering improvement. They declared that tests have shown that the effect on the road structure is the same, with a given gross weight or axle load, for six-wheel trucks as for semi-trailers. In deploring the legislative restrictions on truck sizes and capacities as hampering truck developments, they merely hinted that the cost of building roads and structures capable of handling larger units would be offset by the economy of resulting lower transportation costs.

Progress in motor truck design in the future, as in the past, will be made voluntarily by the truck industry and in response to demands of operators, rather than from requirements of law. In fact, Horine stated, all constructive advances in the past have been voluntary on the part of the industry, while legal restraints have been responsible for most of the uneconomic and unscientific trends.

Trucks in the future, he continued, will be more economical, reliable, safer, better in performance and easier to maintain and operate. Accelerated, perhaps, by minimum performance legislation now threatening, but certain to come in any event, will be a general increase in power-to-weight ratio. Better application of power through wide-range transmissions is coming. Auxiliary transmissions and two-speed axles have already demonstrated the benefits to be derived.

As the present gasoline engine has been developed about as far as possible under the limitations of the Otto cycle and available fuels, future economy lies in the use of larger engines for given loads. The larger engines will operate in their most economical range through improved transmissions. The long improvement in motor fuels will continue. Higher octane, more general utilization of tetraethyl lead, developments in butane and propane, are some of the improvements looked for. In fact, they stated, improvement in fuels may have a serious effect on the future growth of diesel power. However, solid-injection engines are a permanent part of the truck picture, but as they cost more, they will probably replace gasoline engines only in those operations where fuel cost is of major importance, is the belief of the speakers.



H. M. Eby photo

LARGE TRUSSES BEING ERECTED FOR BUFFALO AUDITORIUM

Pin connected trusses 258 ft. long and 62 tons in weight are now being erected for supporting the roof of the $2,500,000 municipal auditorium being built at Buffalo, N. Y. The building will be 260 x 420 ft. and two stories high to occupy an entire city block.

The main auditorium on the first floor will have a seating capacity of 16,000; that on the second floor 1,500. An exhibition hall, with a floor area of 32,600 sq. ft. is located in the basement. Other parts of the building are given over to conference rooms.

The exterior of the building will be faced with gray brick and Indiana limestone.

Green & James, architects of Buffalo, designed the building. The W. F. Hendrick Co., Inc., Buffalo, represented on the job by Harold Walker, is the general contractor.

1940 Road Allotments

(Continued from p. 25)

pended 50 per cent on the state's population, 25 per cent on the mileage of the state's federal-aid system and 25 percent on the railroad mileage within the state.

The funds will be spent under the supervision of the Public Roads Administration with the state highway departments handling design and construction.

Carmody expects the program to be of the same magnitude as in the past fiscal year, which resulted in the improvement of 9,800 miles of rural roads of the federal-aid system, 3,000 miles of farm-to-market roads, and 725 miles within municipalities.

Distribution of the $156,000,000 will be as follows:

State	Total
Alabama...	$3,280,099
Arizona ..	2,042,306
Arkansas .	2,720,217
California.	6,048,689
Colorado .	2,727,881
Connecticut.	1,061,038
Delaware .	780,000
Florida ...	2,167,287
Georgia ...	3,995,118
Idaho	1,837,110
Illinois ...	6,802,015
Indiana ...	3,911,053
Iowa	4,114,562
Kansas ...	4,122,209
Kentucky .	2,900,475
Louisiana.	2,332,675
Maine	1,335,096
Maryland .	1,367,490
Mass.	2,397,135
Michigan .	4,888,128
Minnesota.	4,289,428
Mississippi	2,745,854
Missouri ..	4,768,365
Montana ..	3,031,660
Nebraska .	3,154,631
Nevada ...	1,799,026
New Hamp.	$780,000
New Jersey	2,303,848
N. Mexico.	2,332,948
New York.	8,299,635
N. Carolina	3,775,397
No. Dakota	2,446,151
Ohio	5,905,107
Oklahoma.	3,705,207
Oregon ...	2,466,018
Penn.	7,177,342
Rhode Isl'd	780,000
S. Carolina	2,172,330
So. Dakota	2,494,579
Tennessee.	3,263,228
Texas	9,728,530
Utah	1,656,784
Vermont ..	780,000
Virginia ..	2,916,341
Washington	2,495,370
West Va. .	1,799,715
Wisconsin.	3,858,056
Wyoming .	1,825,100
Dist. of Col.	780,000
Hawaii ...	780,000
Puerto Rico	857,957

Earthquake Causes Damage Over Wide Area in Turkey

A great earthquake in the Anatolia region in Turkey on Dec. 28 brought death and destruction to an area about 185 miles long and 100 miles wide lying to the south of the Black Sea. The severest shocks were felt between 2 and 5 a.m. Three cities having populations around 30,000 are in the affected area. Most of the towns are reported to have been leveled by the force of the quakes, which were followed on Jan. 1 by a severe storm that caused bad floods and added to the destruction in many regions.

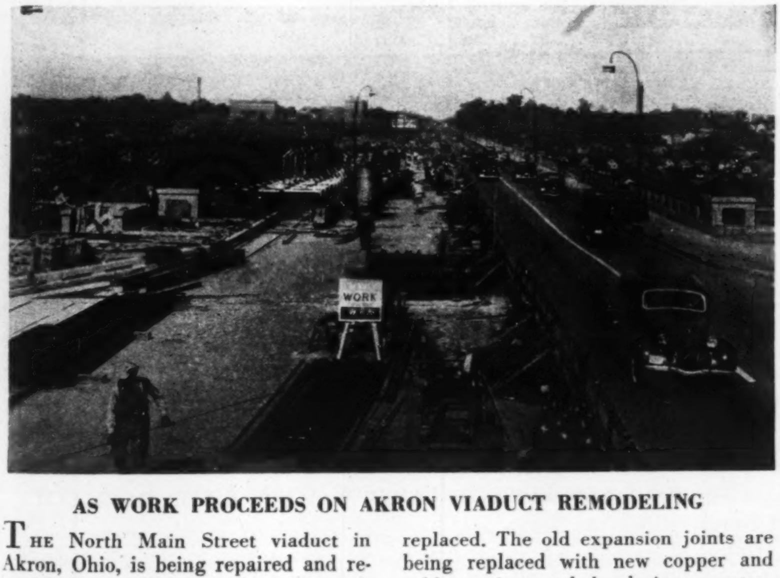
The earthquake in Turkey was accompanied closely by quakes in California, Hungary, South Africa, Italy and Central America.

• • •

Conditions Improve In Drought Area

Rain and snow have alleviated the serious drought condition prevailing over a large portion of the United States (*ENR*, Dec. 21, 1939, p. 811) according to reports from the U. S. Weather Bureau.

A "marked improvement" has been noted in the central and southern districts of the great plains area, with "generous" snow prevailing in the central districts and moderate rains falling in the southern area.



AS WORK PROCEEDS ON AKRON VIADUCT REMODELING

The North Main Street viaduct in Akron, Ohio, is being repaired and remodeled as a WPA project at a cost of $434,000. The structure is 27 years old and about one-half mile in length.

Much of the concrete is spalling and has become porous; this is being chipped off with pneumatic hammers and replaced. The old expansion joints are being replaced with new copper and rubber unions and the drainage system is being improved by the installation of 34 scuppers to replace the six installed in the original construction.

For the work Summit County is supplying $209,000 and WPA $225,000.

Construction Census Gets Under Way

Information and statistics of the industry are being collected as part of census of business

A new census of construction is being taken as part of the census of business, in connection with the Sixteenth Decennial Census just started by the U. S. Bureau of the Census. Actual work on the census started Jan. 2, when 12,000 representatives of the bureau took to the field in search of the required information. An additional force of 120,000 will follow in April. The construction census, first in four years, will record the activities of the industry in 1939 in each state and in each of the larger cities. It will summarize the reports of all general contractors and more than 25 types of subcontractors. The coverage will include all persons and firms engaged in construction for profit, but day labor activities of various public agencies, utilities and industrial firms will not be included. One classification will cover those who did less than $25,000 in business in 1939, including speculative, investment and occasional builders.

Data will be collected on all types of heavy construction, and non-residential and residential buildings. New construction will be listed separately from repairs and maintenance. Public work will be differentiated from private construction. Cost figures will include those of all materials and equipment furnished and installed by contractors, also the sales value of equipment and materials required for the work, but not incorporated in it. The trend of employment and payrolls in the industry will be reflected by a tabulation of employment totals for each month in the year.

Cooperation asked

The Bureau of the Census asks the cooperation of all contractors in answering the question asked by the census takers in order that the task may be completed as soon as possible and the information of interest to the entire industry be released at an early date. All information from firms and individuals is to be held strictly confidential, and used only to compile the general statistics. It cannot be used for purposes of taxation, regulation or investigation.

Other compilations to be made under the census of business, of interest to the construction industry are a census of housing, covering 35,000,000 dwellings; a census of drainage and irrigation; and a census of mines and quarries.

Federal Works Agency Still in Experimental Stage

Activities so far confined to building up a small staff and determining most useful work

Special Correspondence

After six months of existence the Federal Works Agency is still that in name only. It was created by the President's reorganization plan of last summer with very vaguely defined duties and responsibilities, and its activities so far have been confined largely to the building up of a small staff and exploration of what kind of thing it could usefully do.

Great potentiality

FWA is potentially a very powerful body. An independent agency of semi-departmental rank, it has charge of the U. S. Housing Authority, the Public Roads Administration, the Public Buildings Administration, the Public Works Administration, and the Work Projects Administration. At present these agencies maintain substantial autonomy, FWA coordination having only gone so far as consolidation of a few minor service functions such as publicity photography and provision for such cooperative activities as having PBA review USHA specifications or PRA consult with WPA on its airport building. By the end of this fiscal year a few more service functions, such as libraries and printing and mimeographing may be consolidated.

It is unlikely that any administrative economies have yet been achieved by creation of FWA, and in any case this would be impossible to determine since PWA, a dying agency, has been cutting its staff in half, USHA payrolls have been fluctuating violently, and WPA administration was greatly modified by the last Congress.

Now unimportant

Unimportant as FWA now is, its officials have far-reaching ideas. All predictions past November, 1940, must, of course, be conditional, but if the personnel of the agency is not changed it seems probable that within two or three years FWA will become the actual construction agency of the federal government. Procedures are still largely in the luncheon-discussion stage, but it is thought that the agency might take over the specification-writing and contract-letting activities of PBA and PRA (on public land roads), the design-review activities of PRA, USHA, and PWA, and the day labor work of WPA.

To the five subordinate agencies would be left various policy and administrative questions. Thus PBA might determine where government buildings are needed, how much space should be provided, and what architectural style should be followed. USHA would handle living standards, tenant selection, and administration of subsidies. WPA might become a statistical and sociological body determining how much relief employment is needed in various areas. PRA would pass on questions of alignment and traffic standards.

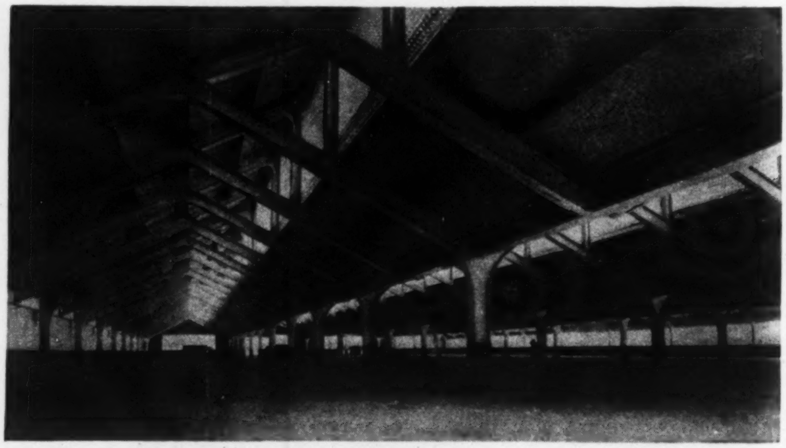
Such a set-up, FWA officials believe, would achieve the economies the President had in mind when he created the agency. Thus the long experience of PBA in building construction could be applied to the problems of USHA, duplication of research staffs studying general problems such as materials could be avoided, and relief labor could be more efficiently used by applying it to the unskilled portions of federal construction projects.

It is unlikely that these innovations would be introduced all at once. Probably individual functions, such as specification writing and research will be consolidated at one time. Consolidation, too, will not necessarily be into one body. Thus two or more bureaus might be set up to deal with different types of research or construction.

• • •

Canada Authorizes Change In Power Export to U. S.

A change in the points at which the Ontario Hydro-Electric Power Commission may export power to the United States was authorized by the federal government of Canada on Dec. 27. The change is looked upon as a significant step in paving the way for approval by Ontario of a future treaty between Canada and the United States for development of the St. Lawrence River. The new permit authorizes the power commission to reduce its export of power in the Niagara district from 80,000 kw. to 50,000 kw. and to export 30,000 kw. at Cornwall, Ont., which is on the St. Lawrence River. Export of power at that point to the Messina plant of the Aluminum Company of America began in Sept. and now totals 25,000 kw. Previously this power had been obtained from the Niagara system by long-distance transmission through the state of New York. The power that now goes across the border at Cornwall comes from the Beauharnois plant farther down the river in Quebec under a contract by which the Ontario Hydro buys bulk power from the Beauharnois company. The export price is stated to be $14.50 per horsepower plus tax.



MODEL OF NEW BUILDING UNDER WAY FOR DIESEL RESEARCH

CONTRACTS for the design and construction of a 10,000 sq.ft. research and development laboratory for the Cummins Engine Co., Columbus, Ind., have been awarded to the Austin Co., Cleveland, Ohio, engineers and builders. Planned to provide the finest testing and engineering facilities available in the diesel industry, this structure will be of welded rigid-frame construction of the type shown in the above picture of the model.

The framing provides a 50-ft. clear span entirely without web members. The saw-tooth aisles are planned to give ideal daylighting conditions.

Forced ventilation will be provided throughout the building.

Charles D. Marx Dies; At Stanford 32 Years

Charles David Marx, emeritus professor of civil engineering at Leland Stanford University, died at Palo Alto, Calif., on Dec. 31. He had been an active member of the faculty for 32 years, retiring in 1923, and long had been one of the best known of the old guard of the faculty that came to the university soon after its founding in the early '90s.

Marx was born in Toledo, Ohio, in 1857. His early education was in Amsterdam, where his father was American consul, in his home city of Toledo, and in Karlsruhe. His professional education was obtained at Cornell, from which he graduated in 1878, and at the Karlsruhe Polytechnikum, where he studied under Steinberg, Baumeister and Grashof.

Early engineering work

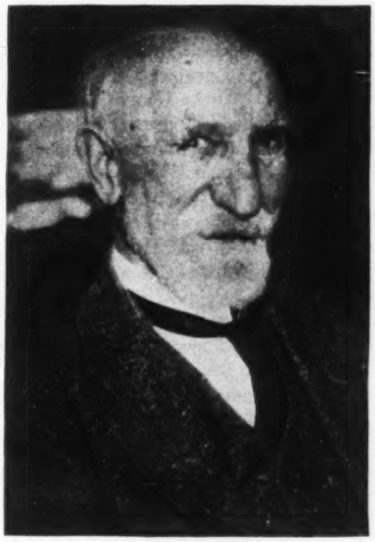
During 1880-81 he served as assistant to Baumeister, and then, returning to the United States, he served as surveyor and engineer on the proposed western extension of the Boston, Hoosac Tunnel & Western R. R., and on river and harbor work, first on the Missouri and later on the Mississippi River improvement. In 1884 he was called to Cornell University as assistant professor of civil engineering, where he remained until 1890. During this period also he acted as chief inspector of public improvements in Rochester and as assistant engineer to the late Emil Kuichling.

Marx became professor of civil engineering at the University of Wisconsin in 1890, but a year later followed a call from David S. Jordan, president of the newly founded Stanford University, to join its faculty, together with several of his former Cornell associates. He remained professor of civil engineering at Stanford until his retirement in 1923.

Active in public life

Marx was the first chairman of the California state water commission, organized in 1911, and had a large part in framing the water laws of the state of California. For many years he was active in the civic affairs of the city of Palo Alto. He served as town trustee, president of the board of trustees, and for many years was chairman of the board of public works. He served on many engineering boards or commissions, was consultant for the state of California on the Central Valley project and on numerous dams, including San Gabriel No. 1, and under President Hoover was chairman of the board of advisory engineers that passed on projects to be undertaken by the R.F.C. He was a charter member of the Society for the Promotion of Engineering Education, and was chairman of the arch dam committee of Engineering Foundation.

The honorary degree of LL.D. was conferred on him by the University of California in 1918 and that of Doctor of Engineering by the Karlsruhe Technische Hochschule in 1925. He was an honorary member and a past president of the American Society of Civil Engineers' past president of its San Francisco section, past president of the Pacific Association of Consulting Engineers, and past president of the Joint Council of Engineering Societies of San Francisco.



Charles David Marx

Unusual personality

Even more than for the high professional standards he set, Prof. Marx will long be remembered affectionately for his kindly and unfailing personal interest in all his associates. "Daddy" Marx, as he was known to his students, retained their interest and affection long after graduation. He remembered each one and always was keenly interested in their success. Wherever engineering graduates of Stanford met, sooner or later there was sure to be kindly reference to "Daddy" Marx.

The influence of his personality as a continuing factor in the lives of his students rested on his direct genuineness; he was incapable of any pretense and he always showed a lively interest in the affairs of his profession and in students he trained in its fundamentals. Part of his life program was practical contact with engineering problems; throughout his teaching career he found time to serve in consulting capacities in many fields.

WASHINGTON HIGHLIGHTS

Special reports by Paul Wooton

CONSTRUCTION contract for the first building of any size to be built entirely by CIO labor was awarded last week. The Cornelius Realty Co. of Indiana awarded to Richard W. Frey of Washington, D. C., a contract to build a $40,000 printing plant in Silver Springs. Md., a Washington suburb. Frey is a member (and president) of Construction Industry Employers, Inc., which recently signed a closed shop contract with CIO's Construction Workers Organizing Committee (*ENR*, Nov. 30, 1939, p. 721). CWOC a few days earlier signed a contract with a West Virginia concern, the Hammond Firebrick Co. providing for wage increases and the eight-hour day. The union has a number of such contracts around the country with building material manufacturers.

THE TENNESSEE VALLEY AUTHORITY will ask Congress to authorize construction of the $25,000,000 Colter Shoals project on the Tennessee River, during the coming session. The project faces a hard fight on the floor of the House, and probably also in the Senate. It is the last of the series of 10 dams on the main stem of the Tennessee. The other nine have already been authorized and are under construction or completed. The Coulter Shoals project, located some 40 miles below Knoxville, will provide the 9-ft. navigation channel up to that city as contemplated in the original TVA Act. Ultimate power installation is 70,000 kw., according to present TVA plans. During this fiscal year, full preliminary plans for the project were completed, although no construction work was done.

• • •

St. Louis Housing Held Tax-Free by State Court

The Housing Authority of the City of St. Louis, created under the slum clearance act passed by the state legislature this year, is exempt from ad valorem property taxes, according to a ruling of the Missouri supreme court made Dec. 5. The ruling, in a test case, apparently clears the way for the housing authority to use a $6,984,000 federal loan approved by President Roosevelt last week.

In handing down the decision the supreme court passed only upon the tax exemption clause, and not upon the constitutionality of the housing act.

OBITUARY

Paul Nash, for many years City Engineer of Stamford, Conn., died Dec. 23 in Stamford. Nash was educated at Sheffield Scientific School and became city engineer of Stamford in 1899, leaving one year later to go into private practice. In 1910 he joined the Yale & Towne Mfg. Co. and in 1902 was reemployed to serve as city engineer of Stamford. In 1908 he became city superintendent of public works.

Alfred E. Davis, manager of the Fred Schmitt Construction Co., was electrocuted Dec. 23 when working on a sewer project in University City, Mo. Davis graduated from Washington University with an engineering degree in 1928.

Jacob J. Jobst, building contractor and former assistant engineer in the general office of the Illinois State Department of Public Works, died Dec. 20 at Fort Myers, Fla. Jobst was made assistant engineer in 1933 and during the past few years had been living in Chicago.

James L. Robinson, 75, retired pioneer general contractor of Minneapolis, died recently in that city. Robinson built the original Dayton Department Store building, the YMCA, the Curtis Hotel in Minneapolis and the Chemistry Building at the University of Minnesota.

Joseph M. Wilson, 46, construction engineer employed on the army building program at Fort Sill, Okla., died in Fairfax, Okla., on Dec. 27. Wilson for a time was with the PWA at Fort Worth, Tex.

Arthur C. McMullen, 51, former superintendent of the Mansfield Ohio water works, died Dec. 23, in that city. McMullen, at the time of his death was employed by the Ohio State Highway Department, but had been renamed superintendent of the Mansfield water works, effective Jan. 1.

Percy Bell, 50, engineer with the Arizona State Land Department, died Dec. 25, in Prescott, Ariz. Bell, for many years was city engineer of Globe, Ariz., and in 1932 joined the Arizona State Highway Department. In 1937 he was transferred to the state land department.

George Strafford Mills, 73, founder and senior member of architectural firm of Mills, Rhines, Bellman & Nordhoff, died in Toledo, Ohio, on Dec. 26. Mills graduated from Washington University in 1884 and in 1912 helped organize the architectural firm of which he was president. Buildings erected in Toledo under Mills' direction include the Ohio Bank Building, the Edison Building, the Toledo Club and the Ohio Bell Telephone Building and the Commodore Perry Hotel, Safety Building and Willys-Overland Buildings.

Henry K. Milner, 73, civil engineer of Birmingham, Ala., died in Mobile, Ala., Dec. 23. After receiving a degree from the University of Georgia, Milner did post-graduate work at Columbia University in mining and civil engineering. He was once in charge of a large engineering project for the Birmingham Water Works Co. At the time of his death he was president of the Milner Land Co., Birmingham, and the Warrant Warehouse Co., Mobile.

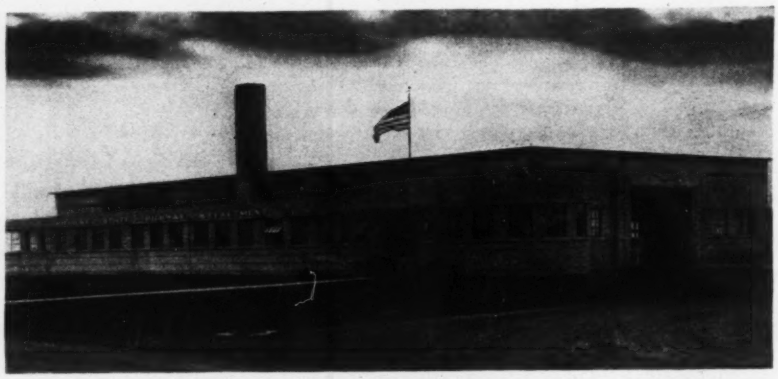
Richard A. Burnett, 72, district supervisor for the North Carolina highway and public works commission, died in Wilmington, Dec. 27. Burnett was made superintendent of the new Hanover County road system in 1920 and had been with the state department since 1933, when the state took over the county road work. He spent most of his time in New Hanover, Brunswick, and Pender counties.

Edson M. Scofield, retired president of the Scofield Engineering Construction Co. of Los Angeles, died in that city Dec. 28 at the age of 72. Scofield, who was a graduate of Union College, Schenectady, N. Y., had been in the building construction industry since 1903, and many of Los Angeles' largest buildings were erected by his company. For a time he was president of the Pacific Marine & Construction Co. of San Diego, Calif., designers and builders of concrete ships.

Fred W. Petit, 55, resident construction engineer for the California State Highway Commission, was killed in a construction accident Dec. 26 on a job near Santa Monica. Petit at one time served as right-of-way engineer for the southern division of the commission.

Samuel C. Lyon, retired building superintendent of the Peoples Natural Gas Co., Pittsburgh, died in that city Dec. 28 at the age of 65. Lyon had been with the gas company 28 years.

Other recent deaths include: Edward S. Snell, 77, retired civil engineer of Seattle, Wash., Dec. 24; Hans M. Hendrickson, 75, pioneer Minnesota bridge contractor, Minneapolis; Alexander J. McCormick, 74, former city engineer of Madison, Wis., Madison; John L. Center, 80, who retired two months ago as superintendent of the city waterworks at St. Augustine, Fla. after 21 years with that department, St. Augustine; J. F. Culpepper, 82, re-



MAINTENANCE GARAGE FOR MICHIGAN HIGHWAY DEPARTMENT

Shown above is the maintenance garage completed late last month at Mt. Pleasant, Mich. for the state highway department. The building is of reinforced concrete, with architectural concrete finish. The main garage, which will house about 30 pieces of equipment, is 61 by 141 ft. A structural steel framework with trusses for supporting the roof was used in this portion of the building only.

The office section is 18 by 146 ft. and the office wing terminates in a complete half circle, giving occupants of the room a view of part of the grounds. Construction for this part of the building was the same as for the garage, except that precast reinforced concrete beams were used for supporting the roof.

The building cost about $41,000 and was built as a PWA project. The Vinton Construction Co., of Coldwater, Mich. was the general contractor and Louis C. Kingscott, Kalamazoo architect, designed the building.

tired building contractor, Birmingham, Ala.; **Claude Waldorf**, 50, builder, Williams, Ariz.; **S. J. Clausen, Jr.**, 53, engineer of Phoenix, Ariz., Clear Lake, Ia.; **Charles W. Thomas**, 70, sewer contractor, Toledo, Ohio; **Ernest Bodensick**, 57, building contractor at Cumberland, Ind. for the past 30 years, Cumberland; **William Edward Parsons**, 67, associate professor of architecture at Yale University, New Haven, Conn.; and **Bert F. Burnett**, in charge of the North Fork Chlorination plant at Asheville, N. C., Asheville.

Cassopolis, Mich. Sued By Sewer Contractor

A suit alleging $20,000 damages was filed Dec. 22, against the city of Cassopolis, Mich. by John Baker, contractor of Kalamazoo, Mich. The contractor claims damages were incurred during the building of a Cassopolis municipal sewer because plans showing a sewer to be built in the center of the street were changed by the order of the supervising engineer. This required the work to be done by hand and resulted in $6,000 extra cost, the contractor claims.

Water Demands Exceed Yield in New York

Progress on needed Delaware Supply described before New York section of A.W.W.A.

How drought conditions this year have emphasized the need of the new Delaware water supply system for New York City was described by Leonard P. Wood, engineer of the Board of Water Supply, before the annual winter meeting of the New York Section of the American Water Works Association on Dec. 28. He stated that water used in 1940 would exceed the safe yield from existing sources by 40 mgd.

Work on the Delaware project, said Wood, was delayed six years by interstate litigation and finally when operations were scheduled to start in 1927, financial difficulties caused further delay until 1937. At the present time, however, $170,000,000 in contracts have been awarded on the tunnel and dam structures for the new system.

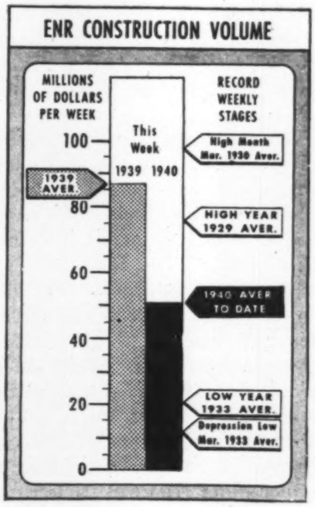
Arthur H. Pratt, chief hydraulic engineer of the New York State Public Service Commission, discussed regulation of water utilities. Private water companies came under the regulatory functions of the commission in 1931, and since that time there have been rate reductions totalling 3½ million dollars, of which $600,000 was voluntarily made. There are 107 private water companies in New York State. Operation of a centralized laboratory for a group of privately owned water supplies was described by John S. Kneale, chemist of the New York Water Service Corporation, Brooklyn, N. Y.

Franklin Henshaw, chairman of the New York Section, presided at the meeting.

(News continued on p. 70)

CONTRACTS AND CAPITAL

Engineering construction awards for the short week due to the New Year's Day holiday total $53,460,000, an increase of 19 per cent over last week, but 39 per cent below the corresponding 1939 week. The high volume of a year ago was due to the rush to get PWA work under contract.



Private awards for the week are 47 per cent above a week ago and 96 per cent above the 1939 week. The increased volume of industrial buildings is responsible for the private gains. Public construction tops last week by 6 per cent, but is 58 per cent lower than last year.

In the classified construction groups, sewerage, industrial buildings, commercial building and large-scale private housing, public buildings, earthwork and drainage, and highways exceed their respective totals of a week ago. Industrial building is the only class of work to top a year ago.

New capital for construction purposes for the week totals $50,281,000, an increase of 104 per cent over last year. The current week's new construction financing is made up of $45,199,000 in USHA loans for low-rent slum-clearance projects in 24 cities, and $5,082,000 in state and municipal bonds.

(Weekly Table on page 23.)

ENGINEERING CONSTRUCTION CONTRACTS REPORTED BY ENGINEERING NEWS-RECORD, IN DECEMBER, 1939

Engineering News-Record *reports projects of the following minimum costs:— water-works, excavation, drainage and irrigation*, $15,000; *other public works*, $25,000; *industrial buildings*, $40,000; *other buildings*, $150,000

Four Weeks — Thousands of Dollars (000 Omitted)

							United States			
							December	Twelve Months		
	New England	**Middle Atlantic**	**South**	**Mid West**	**West of Mississippi**	**Far West**	**1939**	**1939**	**1938**	**Canada**
Public Works										
Waterworks	89	1,166	350	2,574	702	126	**5,007**	162,921	131,209	201
Sewerage	105	2,996	216	2,947	1,435	58	**7,757**	159,822	136,075	90
Bridges, public	206	1,987	1,733	593	1,845	2,764	**9,128**	143,128	126,969	25
Earthwork and waterways	774	2,120	2,595	861	6,159	576	**13,085**	232,590	268,306	61
Streets and roads	267	15,950	6,015	3,598	16,765	2,518	**45,113**	643,771	637,862	339
Buildings, public	6,083	7,051	8,651	3,049	1,954	5,605	**32,393**	592,506	503,000	476
Unclassified, public	702	4,278	5,279	720	4,160	1,163	**16,302**	177,411	187,754	1,495
Total public	**8,226**	**35,548**	**24,839**	**14,342**	**33,020**	**12,810**	**128,785**	**2,112,149**	**1,991,175**	**2,687**
Federal government (included in above classifications)	1,292	1,018	9,266	1,607	6,388	2,198	**21,769**	353,310	367,784	....
Private										
Bridges, private	26	....	....	200	....	....	**226**	7,503	7,664	....
Buildings, industrial	625	1,535	11,257	5,861	2,909	1,079	**23,266**	282,980	152,098	1,520
Buildings, commercial	7,290	16,180	1,950	1,485	2,825	1,948	**31,678**	387,779	549,746	1,470
Unclassified, private	65	895	1,245	1,136	2,455	576	**6,372**	212,445	91,248	25
Total private	**8,006**	**18,610**	**14,452**	**8,683**	**8,189**	**3,603**	**61,542**	**890,707**	**800,756**	**3,015**
Total Engineering Construction										
December, 1939 (4 weeks)	**16,232**	**54,158**	**39,291**	**23,024**	**41,209**	**16,413**	**190,327**	....	....	**5,702**
November, 1939 (5 weeks)	23,752	118,818	39,363	42,543	50,332	27,407	**302,215**	....	....	7,520
December, 1938 (5 weeks)	24,538	107,940	48,721	53,898	62,659	41,494	**339,250**	....	....	10,804
Twelve Months — 1939	174,979	978,402	454,256	536,426	548,612	310,181	....	3,002,856	....	113,056
Twelve months, 1938	148,925	1,053,159	300,399	382,292	497,352	409,804	....	....	2,791,931	90,479

COMMENT AND DISCUSSION

Readers' opinions on matters that concern the engineer

Canal Lined With Cotton

Sir: I have inspected the canal near Soda Springs, Idaho, lined with cotton fabric, described in *ENR*, June 22, 1939, p. 852, a number of times this season and taken measurements for losses which were essentially the same as during the 1938 season as reported in the article. The lining showed no noticeable deterioration. The cotton fabric was installed to check excessive leakage.

E. J. Baird
Civil Engineer
Soda Springs, Idaho

Highway Spirals

Sir: I have read with interest Mr. Barnett's comments on spirals in *ENR* of Oct. 12, p. 457. Although he says that he does not agree with me on the reasons for the non-use of the spiral, his reasons practically embody mine except for placing much of the blame on bad treatment by writers on the subject.

It is true that spiral tables have been in existence for many years but they could not be used because of a lack of clear knowledge of the curve to which they applied. This lack of knowledge of the geometry involved is probably the greatest contributing factor to the non-use of the spiral. It even seems that many of the writers themselves did not have a clear picture of the curve and tried to cover the deficiency by means of tables. The spiral has apparently been tabled to death.

In over 25 years of teaching the spiral I have found that as soon as the students grasp the fundamental geometry of the spiral and its relation to the circle they take to either the equations or the tables easily, generally with a preference for the equations. This may be due to the fact that we require our students to be able to spiral either a simple or a compound curve with no other tables than those of the trigonometric functions.

When field and office men gain this same proficiency they may use either equations or tables as they choose, but to make them dependent on tables is going at the problem backwards, and might even be labeled poor engineering. Tables of the functions of a 1-deg. curve may at times be of assistance in solving circular curves, and similarly spiral tables may at times be of assistance in solving spiraled curves but in neither case are tables essential.

When the basic geometry is understood and when the spiral is approached from the standpoint of curvature rather than fixed length the problems become as mathematically exact as those of circular curves and the computations but little more complex. Under these conditions the various "bugbears" including field delays, trial and error computations, etc. disappear. And even if they did not that is no justification for building unsafe curves. It seems a bit inconsistent to spend, say, $40,000 per mile for a paved road and fail to use spirals because there is a possibility that there might be some delays or extra computations that in all probability would not amount to $10 a mile.

The matter of rate of curvature (length) of spiral is subject to a wide latitude of choice and hence is open to differences of opinion. The railroads early determined a rate for satisfactory spiraling based on comfort to passengers but no similar data seem available for highways. So far we have been limited to minimum length based partly on experimental and partly theoretical mechanics but with no human factor included.

In preparing the material for the recent second edition of "Route Surveying" we desired to supply this deficiency to some extent and this led to the "study" that has been mentioned. Unfortunately this was not done in either the manner or perhaps the extent of a research problem and certainly not with that idea in mind. It consisted of reviewing railroad and highway practice, various publications on the spiral, the experimental work of Professor Moyer, some experimental work by the Illinois Division of Highways in checking a formula for safe speeds proposed by the U.S.B.P.R., some investigations under my direction on the safe or critical speed on highway curves, some measurements of mine on the shifting of gravel roads under traffic, and many observations while driving. The resulting equation was offered as providing some criterion by which to judge the desirable curvature or length of spiral. It is not claimed to be the final word and certainly is open to modification when more data are available.

I agree with Mr. Barnett that this question might well be made the subject of specific study and might well be considered as a project by the Highway Research Board.

C. C. Wiley
Professor of Civil Engineering
University of Illinois, Urbana, Ill.

Sir: I have watched with some interest the discussion on the subject of the practicability of the use of the spiral in highway construction. It all strikes me as being rather futile for engineers to spend much time in worrying about something as evident as the need for the spiral on paved roads.

It is an accepted fact that the spiral coincides with the superelevation transition and thereby makes the rate of curvature and the superelevation at any point on the curvature concur. This condition will make the curve approach ride more easily and tend to keep the traveler in his own lane.

The above being, I believe, an accepted fact, why discuss the matter? Highways are being improved for the comfort and safety of the traveling public, so why not do as the Missouri State Highway Department has done, prepare a simple set of tables for the field party and use the spiral.

Samuel Gaston
Wayland, Iowa

Sir: I have noticed considerable comment on the highway spiral in recent issues of *Engineering News-Record* by various authors and wonder why some of them don't take the trouble to refer to a copy of "Transition Curves for Highways," by Joseph Barnett, senior highway engineer, of the Bureau of Public Roads. It costs only 60c. from the Superintendent of Documents, is an excellent field and office manual, and would save a great deal of argument and possibly some headaches for those who think they have something better.

Barnett's Highway Spiral is essentially an adoption of the Talbot Railway Spiral to highway requirements and does not differ either in theory or principle from the Talbot Spiral except that it is expressed in terms of arc length instead of chord length, which is the practice in railroad curves.

Talbot's Spiral is just as applicable to curve transition problems today as when first brought out by Arthur N. Talbot some forty years ago because it is fundamentally correct and by far the simplest and most practical spiral for field application that has ever been designed for either railway or highway curves.

It might be well for some of our critics of the spiral to take a better look at the Talbot Spiral or Barnett's adoption of it before talking about the difficulties of spiralling a curve.

A. Tiggelbeck
Consulting Engineer
Sandpoint, Idaho

Publicity for Engineers

Sir: In your Oct. 12 issue, p. 457, J. A. Varela brings out some pertinent points in commenting on Farley Gannett's article titled, "Why So Few Famous Engineers Today?"

The subject of publicity for engineers is keenly interesting to me; therefore, I should like to submit some of my own observations. They are not the result of extensive travel and study, and may have only local application, but from what I have read in Engineering News-Record, engineers all over the country have the same or similar difficulties.

In my opinion our national government has contributed largely to the present deplorable state of the engineering profession.

Let us take as an example the housing projects which are now in vogue. The U. S. Housing Authority requires on all drawings a comprehensive title stamp which lists the names of all officials from the consulting engineer to the Administrator himself. But the consulting engineer (at least in all cases which have come under my observation) has general charge of the construction work *after* the structural design has been made. There is no provision for recognition of the structural engineer.

On the other hand, lack of publicity is due in part to the shortcomings of the engineers themselves. The engineer, as a rule, is inarticulate. If he hopes to get publicity, he must learn to talk interestingly of his work. He must learn the value of showmanship. He must not carry the showmanship so far as to lower the dignity of his profession, but it is a fact abundantly proved that the men best known to the public, now as in the past, not only in engineering but in all other fields of endeavor, are the ones who have combined romance, glamour, and showmanship with technical ability.

There is another way in which engineers differ from men of other professions, notably lawyers and doctors. The average engineer is too often ready, with grim determination, to pounce upon the errors of his fellow engineers. He is always ready to criticize, to "show up" the other fellow to his own advantage. I do not think I have ever heard a lawyer or a doctor speak disparagingly of the ability of other members of their professions. They have a code of ethics, and such a code is necessary to keep a profession on a high plane. Eternal squabbling is not conducive to dignity.

I. E. Morris
Structural Engineer,
Birmingham, Ala.

Business Against War

Sir: Mr. McGraw's message, "Business Stands Against War," *ENR*, Oct. 12, p. 64, leads this reader to express his belief that the message will strengthen the resolution of those who aim to keep our country out of war.

Aggressor nations are usually careful not to attempt the conquest of countries whose strength is about equal to their own, and as long as we are able to maintain well equipped and efficient defensive forces there is little likelihood that they will be needed for repelling invaders. The longer we keep out of wars outside our boundaries, the better.

If we, in relation to other nations, were like a well organized police department in a great city, charged with the duty of keeping order, suppressing riots, and capturing criminals, then we might try to keep the peace and administer justice throughout the world; but no nation is powerful or wise enough to do that.

I hope Mr. McGraw's message will help to confirm opinion among business men and women and other individuals that it is our privilege and duty as well as to our interest, and possibly to the best interest eventually of many sorely tried but brave and honorable men and women across the sea, to do what we can to keep the United States of America out of war as long as it is humanly possible.

Frank S. Bailey
East Braintree, Mass.

Continuity Adjustments

Sir: In the editorial entitled "Not So Complicated" on p. 63 of your issue of Dec. 7, 1939, the statement is made, with reference to the continuous truss of the Guntersville Bridge described in my article on p. 75 of the same issue, that "the engineers found that a variation of the end supports with relation to intermediate supports of as much as 7 in. either up or down from normal position caused no overstressing of the truss members."

In order to avoid any misunderstanding of the facts of the case, I should like to point out that the variation of 7 in. from the normal position of the end bearings was permissible only because no live load was allowed on the structure, and the working unit stresses were increased for the construction operations. If a continuous truss is closely designed, any change in the relative elevations of the supports will cause overstress in some member. However, it is true, as you imply in your editorial, that the rate of stress increase is usually surprisingly small so that extreme refinement in adjustment of the bearings is not required.

Erwin Harsch
Senior Structural Engineer
Tennessee Valley Authority

Tables of Segments

Sir: I have read your favorable comments about C. K. Smoley's tables of circular segments, (*ENR*, March 31, 1938, p. 38). I agree that they are excellent, but wish you to know that the idea back of them is old, as indicated by the fact a booklet entitled "Tables for Use in Computing Arcs, Chords and Versines", prepared by me, was published in 1930 by the Chicago Bridge & Iron Co.

H. C. Boardman
Chicago Bridge & Iron Co.
Chicago, Illinois

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To Our Readers

WITH this issue, Waldo G. Bowman becomes co-editor of ENGINEERING NEWS-RECORD with F. E. Schmitt, who has been at the helm since 1928. This new assignment is made in the belief that engineering and construction are on the threshold of a new era of expansion and is in line with the traditional policy of the paper to expand its editorial resources in keeping with the needs of the field.

Waldo Bowman is known personally by many of the readers of this journal, having been on its editorial staff since 1925. He has served as executive editor of the paper for the past year, and before that as associate editor, specializing in bridges, buildings and engineering research. He also has taken an active interest in contractors' problems, highways and professional affairs.

ENGINEERING NEWS-RECORD was established in 1917 by consolidating ENGINEERING NEWS, established in 1874, and ENGINEERING RECORD, established in 1877. Now with a further expansion in editorial facilities, the publishers are confident that the paper's usefulness to its field will be even greater in the future than in any time during its 66 years of service to engineers and construction men.

JAMES H. McGRAW, JR.
President,
McGraw-Hill Publishing Company, Inc.

• • •

Highways in the Spotlight

HIGHWAY DEVELOPMENTS take the center of the stage in the construction industry during the next few weeks. Roadbuilders and equipment manufacturers will soon be on their way to Chicago for the annual meeting of the American Road Builders Association and the always impressive Road Show. In Washington, Congress will begin to discuss the necessary financing of road work in which the highway needs for national defense are sure to be accorded prominent attention. Throughout the industry, there is a tendency to recall and re-examine progress in roadbuilding, engendered by the fact that the year marks the 25th anniversary of the founding of the American Association of State Highway Officials and the beginning of federal aid. And as always, there is the looking forward to next year's prospects and planning. Because these three elements—national defense roads, a quarter century progress in roadbuilding and progress for 1940—are the highway highlights of the day, they will constitute the subject matter of the annual highway number of *Engineering News-Record*, Jan. 18. Every reader should be interested in that issue, for next to homes, highways are the most universally used product of the construction industry.

It's Hard to be Thrifty

CREDIBLE RUMORS that the popular year-end sport of budget-cutting has been taken up by the federal government contain both good and bad news for construction. Some of the major cutting is to be done in public works, which means less federal business for contractors; however, the reduction, by bringing the national accounts nearer to balance, should encourage private enterprise to go into new construction, which would probably result in a net gain. If the government does become thrifty the average citizen will welcome the change as a promise of better times. However, the rumors of budget-cutting at once brought protest from champions of special interests. The spokesmen of pressure groups, keeping their eye on votes, will make it difficult for Congress to be thrifty.

Masterly Performance

THE SANDHOG'S WORK under river mud and sand has ever been difficult and dangerous—more difficult than any occupation in the whole range of construction. And especially when rock and boulders are combined with soft ground the risk of overwhelming inrush of ground threatens disaster each moment. All these conditions were present in their worst combination under the East River at New York where the Queens-Midtown Tunnel had to be constructed, and because of this fact the driving of the tunnel represents top-rank performance, of highest credit to the engineers, contractors and workers who carried it through to success. A factual account of the work gives at best only a rough idea of the courage and determination required and the sure judgment and skillful resource that brought success. Two critical periods in the work, in one case failure of the whole heading face, in the other a flow of water that almost filled the tunnel while the sandhogs kept up their fight to hold it down, will long stand as high spots in under-water tunneling records, an inspiration to attack even more difficult tunnel problems whenever these may be encountered.

Architectural and Structural

FABRICATED CONCRETE is rapidly emerging as a new constructional material having important possibilities. Its use to excellent effect as facing of the great naval model basin at Carderock, near Washington, and its proposed application to the new naval hospital emphasize these possibilities. A smaller but equally significant application is that at the Westport Bridge on the Merritt Parkway. Here as in some building uses the precast slabs served both as outer wall form and as permanent facing so far the essential service of the material has been decorative and protective. But the strength of the material—7,500 lb. per sq. in. minimum specified at Westport, and reported test strengths of 10,000 lb. and more—suggests that it can also be used advantageously as a structural element. When properly adapted to service as column and wall units such high-strength slabs appear to have inviting possibilities in developing new types of structural assemblage.

Monuments for the New Year

ONE OF THE often neglected elements of municipal engineering is the establishment of a system of survey monuments and the preparation of accurate block maps. This is a serious omission because basic information of this kind is the starting point for practically every public works improvement and private development. If only as a service to himself, the municipal engineer can do nothing more useful in eliminating some troublesome headaches than to correct deficiencies in survey monuments and maps of his community. How to carry out a job of this kind is effectively told in an article on p. 51 of this issue. Aside from the fact that this is the period when good resolutions should be put into effect, this is also the time of the year when field men and office staff can best be employed on extra-curricular activity of special value such as monumenting.

Works Programming

AN unusual experiment has been in progress during the past year. At the suggestion of the National Resources Planning Board several cities and towns in different parts of the country have undertaken to program their public works for a six-year period, on the basis of study of present and prospective need for the improvements. Winchester, Mass., was first to complete this programming. Kalamazoo, Mich., recently reported its procedure before the American Public Works Association, and within the past week Fargo, N. D., published a report on its programming operations. In each case it is expected that the wastes and losses of opportunistic planning can be avoided, while retaining full responsiveness to public demand.

Perhaps the best feature of such programming is that it leads to sound financial management and maintenance of public credit. When major operations such as street repair or school modernization are foreseen several years ahead and provided for by the program in due relation to needs and revenues, community finance will automatically be managed with due foresight. The end in view, of course, is better public service at less cost and with less strain on tax lists and on public debt—matters of great importance to cities large and small.

However, the test of whether the present experiment succeeds is not so much a lowered tax rate as public satisfaction with superior service and better ordered finances. If the plan succeeds by this test, then it may be worth extending to larger governmental problems, such as those of an entire state. While the public works of our major governments have essentially different character from those of a city, management efficiency stands to gain as much in the one case as in the other. It is therefore to be hoped that tangible proof of the benefits accruing from advance programming will soon be brought forward, so that programming may find general adoption in government practice.

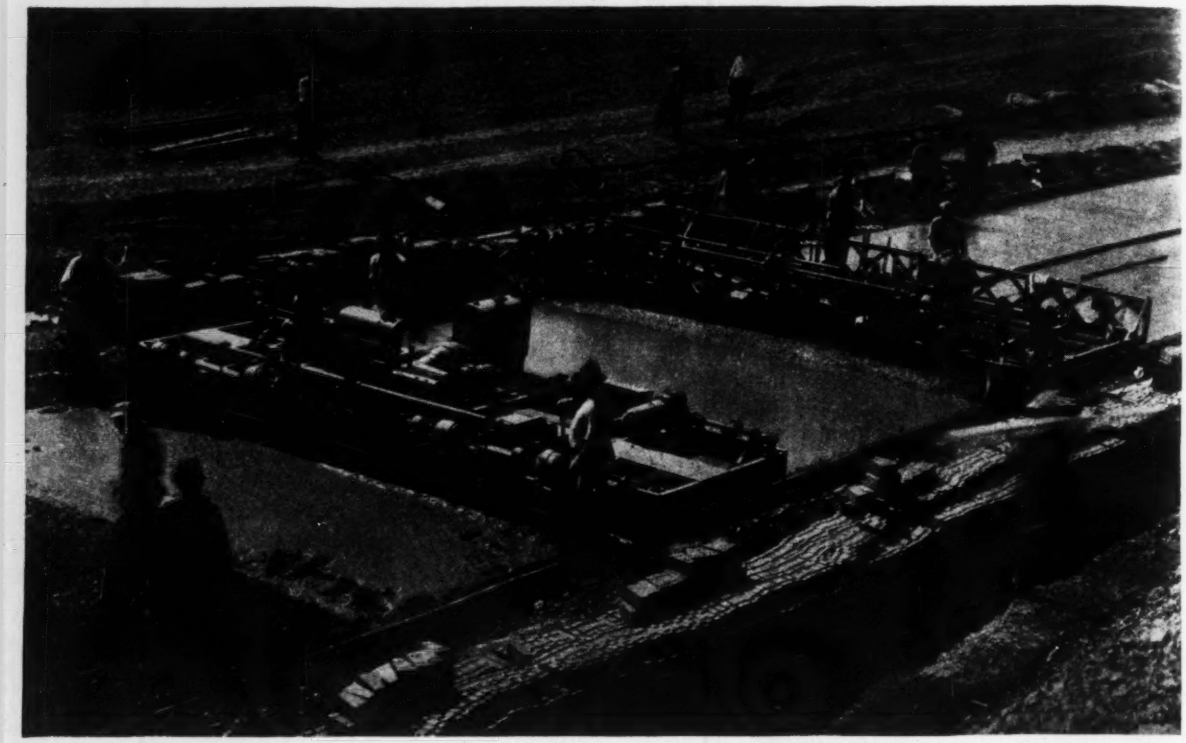

FIG. 1. OHIO CONSTRUCTS BASE FOR BRICK SURFACING TO THE MACHINE ACCURACY OF FINISHED CONCRETE PAVEMENT.

Machine-Refined Brick Paving

George J. Thormyer
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***Contents in Brief**—A new trial of monolithic concrete base and brick surface is reported in this article. The brick lip curb is a novel detail. Base and surface jointing is closely synchronized. Bricklaying by hand is the only operation not machine-performed. A vibrating templet replaces the rollers formerly used for final surfacing to profile.*

FOLLOWING AN EXPERIMENT made in 1938 in building 2.2 mi. of vibrated monolithic brick pavement (*ENR*, Dec. 1, 1938, p. 704) the Ohio state highway department has completed recently a slightly shorter (2.135 mi.) pavement of improved design. The new structural elements of principal importance are a lip curb of specially shaped brick, curb inlets for surface drainage and a combination expansion joint of unusual construction. All construction operations except dropping the brick were mechanized and some of the machine attachments used were developed for this operation.

The new pavement on U. S. Route 30 in Stark County begins in the village of East Canton and extends east 2.135 mi. Within the village limits the pavement is 40 ft. wide with a crown of 4½ in. and with 6 x 18-in, sandstone curbs. The reinforced concrete base is 7 in. thick and the brick surface is 3 in. thick. In the rural portion of the project the pavement is 22 ft. wide; the reinforced concrete base is 9 in. thick at the edges tapering to 7 in. 2 ft. from the edges, and the brick surface is 3 in. thick except at the edges where edge brick, made to provide a 3-in.-high lip curb, are placed in the outer 9 in. The brick are vertical-fiber lug brick with wire cut surfaces top and bottom. The lugs provide a $\frac{3}{16}$-in. minimum space between brick.

The longitudinal joints are of the premolded bituminous ribbon type, the ⅛-in. ribbons extending from the surface of the brick 2½ in. into the concrete base. These joints were placed in the concrete from an independently operated machine, Fig. 1. Steel plates held the upper portion of the ribbon vertical until the bricks were laid. Expansion joints 1 in. thick are provided at maximum intervals of 120 ft. These joints are a combination of premolded bituminous material extending from the subgrade to within 1 in. of the surface of the base and of self-expanding cork to the surface of the brick. Deformed metal plates on both sides of the bituminous material provide chambers for extrusion of the bituminous material when the joint is compressed. These plates extend above the top of the bituminous material to within ¼ in. of the surface of the base, forming a slot in the base into which the bottom edge of the self-expanding cork is inserted. To prevent concrete from entering this slot a removable cap was placed over it until the base finishing equipment had completed its operation. The crew placing the longitudinal ribbon joints removed the cap and placed the self-expanding cork in the opening to extend upward to the surface of the brick. The joint filler was cut to fit the thickened-edge cross-section of the pavement.

General construction procedure

Experience with the road built a year ago established the fact that machine-finished construction guaranteed precision and riding qualities, but further to assure this precision, rigid control was exercised on the subgrade and each detail of base and surface construction.

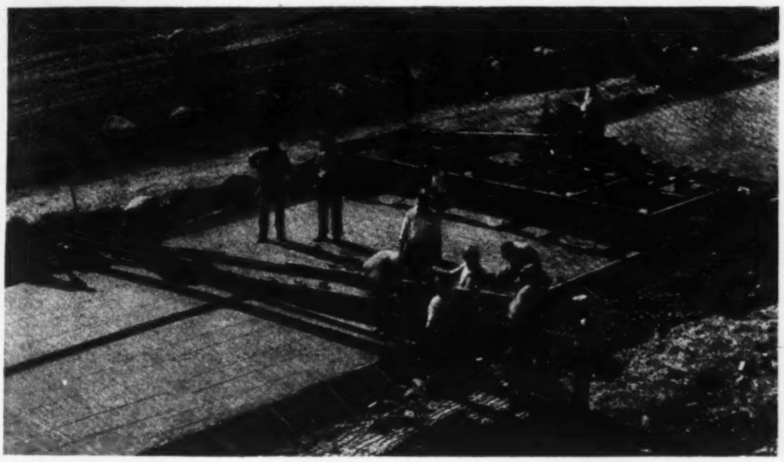

Fig. 2. Just behind the two-deck roller conveyor that served the bricklayers came the machine specially designed to vibrate simultaneously the paved surface and its brick lip curb.

The type of soil was first determined by a soil profile which furnished data for draining and soil treatment. The subgrade material in cuts if objectionable was removed and replaced with acceptable material compacted to the density required by the specification for that type of material.

The consistency of the concrete for the base was kept as nearly constant as possible. Because of the nature of this type of construction the base must be sufficiently plastic to insure bond and at the same time be firm enough to stand up while the brick are placed and vibrated. A wet batch of concrete can result in a depression in the surface and a consequent high area surrounding it. The surface was therefore tested between the operations of vibrating and grouting and where high or low spots existed the brick were removed and the base adjusted. It may be stated here that careful control resulted in this adjustment rarely being necessary.

The brick-dropping operation did not differ materially from that of any other brick surface construction but, the brick having been culled in advance of delivery, culling after the brick were placed in the pavement was held to a minimum.

Vibrated monolithic brick construction requires the use of a steel extension form (Fig. 4) which is clamped and braced to the base form for the twofold purpose of holding the brick and grout in place and for serving as a track for the brick-vibrating machine. The use of edge brick required a height of 6½ in. for the extension form but the method of clamping and bracing held it very rigidly in place. Prior to the placing of the extension form the vibratory finishing machine and joint machine which carried a screed for the final finish of the base had completed their operations. The interval of time be-

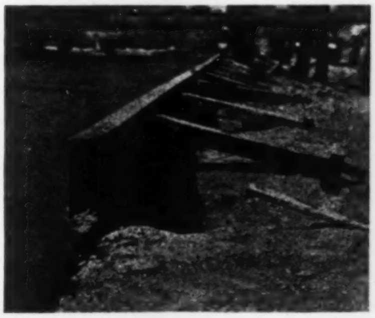

Fig. 4. An extension on top of the concrete base forms provided a track for the brick surfacing machines.

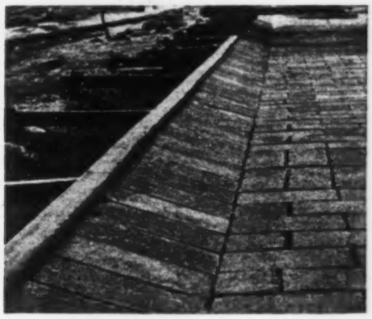

Fig. 5. Lip curb of wedge shaped brick vibrated and grouted with the surfacing brick.

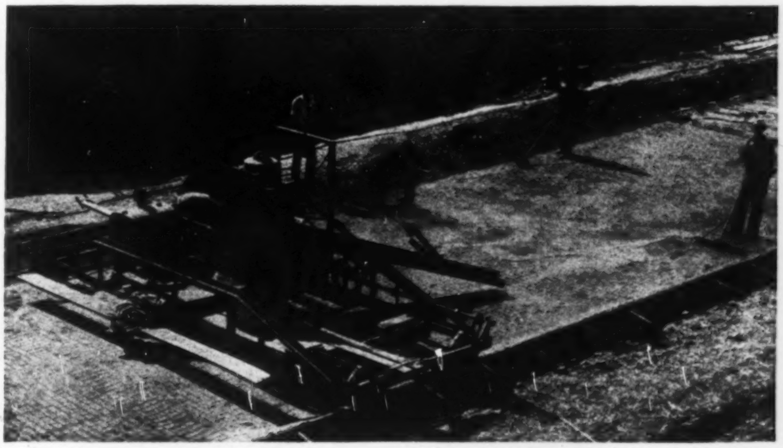

Fig. 3. In filling the joints with cement grout a carriage-mounted grout mixer with a swinging chute provided full pavement width service to the broomers.

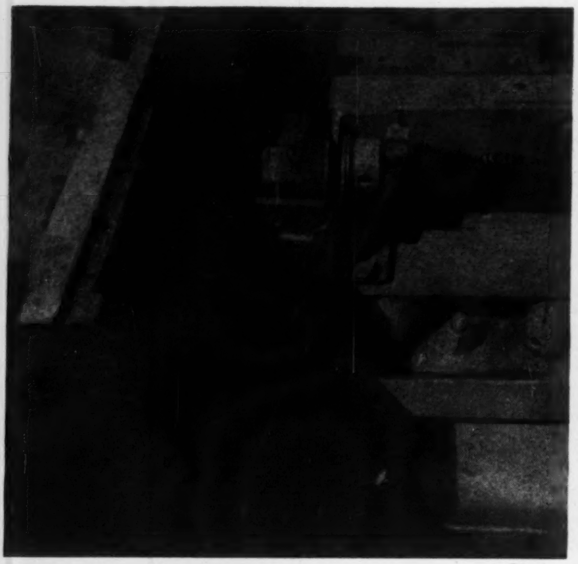

Fig. 6. An attachment to the surface vibrator simultaneously settles and bonds lip curb brick.

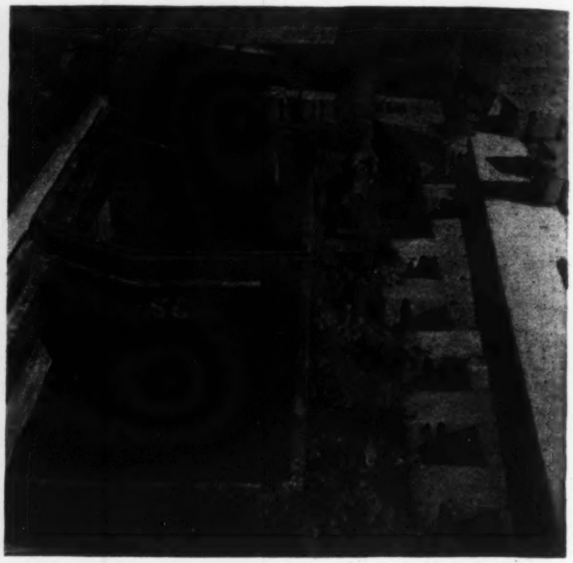

Fig. 7. Inlets are set in the lip curb at discharge points for surface drainage.

tween the pouring of the base and dropping the brick varied from 1½ to 3 hr. depending upon temperature and relative humidity. During this lapse of time the extension forms were clamped on and braced. The edge brick were placed just ahead of the regular brick-dropping operations. Roller carriers conveyed the balance of the brick to the droppers.

On each side of the transverse expansion joints the first course of brick was laid with the long dimension parallel to the centerline of pavement. The balance of the brick were laid with the long dimension normal to the center line. Laying was started at either row of edge brick and progressed to the longitudinal joint where the closure was made by batting with no less than one-third of a brick. Starting at the longitudinal joint, laying continued to the opposite row of edge brick where closure was made in the same manner.

Vibrating followed the dropping. One pass of the vibrator was usually sufficient to remove surface irregularities. The average settlement of the brick into the base varied from $\frac{1}{16}$ to ⅛ in.

The grouting machine consisted of a one-bag mixer mounted on a frame with wheels using the forms for track. A chute conveyed the grout to the surface of the pavement. A second application of grout usually filled the joints and the final finish was accomplished by dragging wet burlap over the surface. The work was cured by covering immediately following the grout filling operation with burlap which was kept wet for 24 hr. At the end of the 24-hr. period the burlap was removed and the pavement covered with 3 in. of straw which was kept wet until 6x6x40-in. beams made from concrete identical with that placed in the base showed the required modulus of rupture.

Curbs and inlets were special

In order to lessen berm maintenance it was desired to convey the surface water on the pavement directly to underground conduits which meant that a curb must be provided. A monolithic concrete curb was objectionable with a brick surface course of this type due to its difficult construction as well as cost. The result was the conception of the edge brick previously mentioned. The design called for brick 4 in. wide, 9 in. long and of a depth sloping from 6⅛ in. on one end to 3⅛ in. on the other, the plane of the ends being normal to the under side of the brick as it is laid in the pavement. The top and bottom of the edge brick were required to be wire-cut, and the sides and the end to have lugs giving an opening between brick equal to that in the 3-in. surface course. The added ⅛ in. of depth on the edge brick was to insure its being embedded ⅛ in. deeper into the plastic base for greater bond and additional insurance against overturning.

The Flexible Road Joint Machine Company of Warren, Ohio, designed and constructed a machine which vibrated the edge brick (Fig. 6) simultaneously with the surface brick.

The inlet basin walls first were built of brick to the subgrade elevation. This permitted the subgrading machine to operate over the basin. The walls were then completed to the required height to receive the casting and the basin area was boxed out, the top of the box being set to the elevation of the surface of the concrete base. After the vibratory finishing machine completed its operation on the concrete base a 3-in.-high extension box was placed over the lower box and the operation of placing and vibrating the brick was completed.

Immediately thereafter, the casting was set, the box removed and the balance of the base concrete placed.

Credit for the conception of vibrated monolithic brick pavement is due The Metropolitan Paving Brick Co. and credit for the design and construction of the brick-vibrating machine goes to the Flexible Road Machine Co. of Warren, O. Field work was supervised by W. L. Belknap, resident district deputy director, R. R. Tinkler, project engineer, Homer E. Anderson, resident division deputy director, C. R. Hanes, inspector engineer for the bureau of construction of the Ohio Department of Highways, of which Col. Robt. S. Beightler is director and Hal G. Sours is chief engineer. The contractor was Garaux Brothers of Canton, Ohio. The Public Roads Administration bore half the cost.

Sheave Design and Wire Rope Economy

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***Contents in Brief**—Wire rope life may be greatly lengthened if the bending forces which cause fatigue cracks can be reduced. Proper sheave and drum design, as to diameter, material and groove size, and proper rope selection, as to flexibility, are important factors in reducing bending stresses. The principles which govern proper evaluation of these factors are discussed in this article.*

THE SERVICE OBTAINED from wire rope is closely related to the design of the sheaves and drums over which it has to operate, for example their diameters, the shape of the grooves, and the material of which the sheave or drum is made. Then there are two classes of sheaves and drums which affect the problem: (1) those in which dimensions are severely limited by the nature of the machine; and (2) those in which some latitude is allowed in sheave and drum diameters. In the former class fall such devices as drums on pavers and cranes, tackle blocks, and the closing sheaves of clamshell buckets. The latter class includes drums and headframe sheaves for shaft and skip hoists, elevator drums and sheaves, and the like. Knowledge of the considerations which govern sheave and drum design or conversely, with given sheaves or drums, the choice of the proper wire rope, is important to construction men.

Background of problem

When a wire rope passes onto a sheave or drum, it changes from a straight line to an arc of a circle, and the resulting bending stresses depend on the flexibility of the rope and the diameter of the sheave. When the same element of rope passes off the sheave, it changes in shape from an arc to a straight line, which relieves the bending stresses. These bending stresses are added to the stresses caused by the load, and hence their effect is to increase the total stress in the rope wires at each point of bend. Hence the total stress in each element of the rope changes as the element passes onto a sheave and again as it passes off the sheave. This frequent change in stress causes an embrittlement of the rope metal known as fatigue, exhibited in the form of minute cracks which soon spread across the wire section, causing a break. The deterioration of ropes by drums and sheaves is due almost entirely to fatigue, the factor of wear being relatively unimportant if the sheaves and drums are properly designed and placed with relation to one another.

A wire rope consists of several strands twisted around a core, and each strand consists of several wires twisted together. Consider a small-diameter rod on which is machined a single spiral thread having a relatively long pitch. If we bend this threaded rod around a sheave, we set up maximum tensile stresses in the thread at those points farthest away from the sheave, and maximum compressive stresses in the thread where it lies next to the sheave. Two such adjacent points of maximum tensile and compressive stress would be separated by a distance of half the thread pitch. Each of the strands of a rope may be likened to such a thread, with the difference that the rope strands have a certain degree of freedom in sliding along each other and embedding in the hemp core, and the individual wires in each strand also are capable of some adjustment independent of the other wires. Hence, in a wire rope we can expect some degree of equalization of the stresses, with a perceptible lowering of the maximum stresses made possible by the sliding of the strands and of the individual wires.

However, to guard against fatigue in ropes, bending stresses should be kept as low as possible. Therefore, with sheaves of small diameter, a highly flexible rope is indicated. Wire ropes having many small wires are more flexible than those having a few large wires. If, however, ropes consisting of a few large wires are used, such as 6x7 construction (6 strands of 7 wires each), resort must be made to sheaves and drums of relatively large diameters. The maximum bending stress is proportional to the rope diameter and approximately inversely proportional to the sheave or drum diameter. Therefore, for any given construction of rope, the greater the value of D/d (tread diameter of sheave divided by diameter of rope), the smaller will be the bending stress and the slower will be the development of fatigue.

Calculating sheave sizes

In a problem involving the moving of a certain load by means of a single rope, the resistance to the pull created by the dead weight of the load and rope, together with the load represented by the acceleration and friction, produces in the rope a certain amount of tension. By multiplying this tension by a factor of safety (never less than 5 for working ropes), the minimum allowable breaking strength of the rope is obtained. By referring to Table 1, the size of rope required can then be selected.

Knowing the diameter of the rope, and its construction and material, the most desirable diameter of the drum and sheaves can be determined by judicious use of Tables 2, 3 and 4, although it is proper to point out the controversial nature of this subject. While wire-rope manufacturers are generally in agreement on recommended sheave and drum diameters, yet some manufacturers of rope-using equipment claim that drums and sheaves made to these recommended diameters would be impracticable for many kinds of equipment because of space limitations and considerations of weight. Recognizing that smaller drums or sheaves may at times be justified even at the expense of lessened rope life, rope manufactur-

TABLE 1 — WEIGHTS AND BREAKING STRENGTHS OF WIRE ROPE

	6 x 7 Rope			**6 x 19 Rope**		
		Breaking Strength, Tons*			Breaking Strength, Tons*	
Dia. In.	Weight, Pound per Ft.	Improved Plow Steel	Plow Steel	Weight, Pound per Ft.	Improved Plow Steel	Plow Steel
1-½	3.38	86.5	75.	3.60	92.5	80.5
1-⅜	2.84	73.5	63.5	3.03	78.5	68.
1-¼	2.34	61.	53.	2.50	65.	56.5
1-⅛	1.90	50.	43.6	2.03	53.	46.
1	1.50	40.	34.8	1.60	42.	36.5
⅞	1.15	30.8	26.8	1.23	32.2	28.
¾	.84	22.8	19.8	.90	23.7	20.6
⅝	.59	16.	13.8	.63	16.6	14.4
9/16	.48	13.	11.3	.51	13.5	11.7
½	.38	10.3	9.	.40	10.8	9.4
7/16	.29	7.9	6.9	.31	8.4	7.3
⅜	.21	5.9	5.15	.23	6.3	5.5
5/16	.15	4.2	3.65	.16	4.5	3.9
¼	.094	2.7	2.35	.10	2.9	2.5
	6 x 37 Rope			**8 x 19 Rope**		
1-½	3.49	88.2	76.7	3.26	79.5	69.
1-⅜	2.93	74.3	64.6	2.74	67.	58.3
1-¼	2.42	61.5	53.5	2.27	55.7	48.4
1-⅛	1.96	49.9	43.5	1.84	45.2	39.4
1	1.55	39.5	34.4	1.45	35.8	31.2
⅞	1.19	30.5	26.5	1.11	27.6	24.
¾	.87	22.8	19.8	.82	20.5	17.8
⅝	.61	16.1	14.	.57	14.4	12.5
9/16	49	13.2	11.5	.46	11.8	10.3
½	.39	10.6	9.2	.36	9.5	8.2
7/16	.30	8.3	7.2	.28	7.3	6.3
⅜	.22	6.1	5.3	.20	5.45	4.7
5/16	.15	4.4	3.8	.14	3.85	3.34
¼	.10	2.8	2.4	.09	2.47	2.15

* For ropes with wire centers or strand centers, add 7½ to 10 per cent to strength listed for 6-strand ropes.

ers, nevertheless, hold that the only practical solution to the problem of rope deterioration is the use of sheaves and drums that do not introduce high bending stresses in the rope.

In recent years improved materials have been introduced in ropes and new constructions have been added to meet the wide requirements of industry. A development of particular benefit to the users of wire rope is the process of preforming the wires and strands in the last stage of manufacture of the rope, thereby obtaining a construction that is more resistant to fatigue, less inclined to kink, and easier to reeve and to handle. Also, when the individual wires and strands of a rope are formed precisely to their final shape in the manufacture of rope, and therefore lie dormant, as in the case of preformed rope, the individual wires do not press outward on one another, and friction between wires is lessened, with the result that such rope is more flexible and the maximum bending stresses are less.

There has also been a pronounced movement in the direction of redesign of equipment to allow sheaves of larger diameter for the handling of working ropes. Thus the equipment manufacturers, too, are doing their bit toward licking the problem of fatigue in wire ropes.

The determination of sheave and drum diameter is, in the final analysis, a matter of balancing rope savings against other economies. A change from small to large diameters for headframe sheaves, for example, will save more dollars in rope than a similar change in the case of equalizing sheaves on cranes. This is because the headframe sheave introduces large bending stresses of an alternating character into the rope throughout most of its length, and hence fatigue breaks soon occur in the wires with consequent discarding of the entire rope, while in the case of the equalizing sheave on a shop crane the movement of the rope over the sheave is very slight and hence the fatiguing action is slow and rope life is comparatively long. Therefore, the cost of large sheaves may be justified on headframes when it would not be for a crane equalizing sheave.

TABLE 2 — AVERAGE SHEAVE AND DRUM DIAMETERS

For 6x7 rope, 72 × rope dia.
For 6x19 rope, 45 × rope dia.
For 6x37 rope, 27 × rope dia.
For 8x19 rope, 31 × rope dia.

(For standing ropes, the above diameters can be cut almost in half.)

TABLE 3 — MINIMUM SHEAVE AND DRUM DIAMETERS

For 6x7 rope, 42 × rope dia.
For 6x19 rope, 30 × rope dia.
For 6x37 rope, 18 × rope dia.
For 8x19 rope, 21 × rope dia.

TABLE 4 — CRITICAL SHEAVE AND DRUM DIAMETERS

6x7	28 × rope dia.
6x19 Seale	20 × rope dia.
6x19 Warrington	16 × rope dia.
6x19 Filler Wire	16 × rope dia.
6x37	14 × rope dia.
8x19 Warrington	14 × rope dia.
8x19 Seale	16 × rope dia.

Another problem in economics is that of sheaves over which is operated only a small section of rope located near the end, such as the sheaves on the closing mechanism of a clamshell bucket. Though these sheaves are necessarily of small diameter because of space limitations, yet if large sheaves were practicable they would scarcely be justified because the practice of cutting off the damaged end of the rope at frequent intervals, and compensating by letting out more rope at the drum end, results in only a small waste compared to discarding the entire rope. Finally, it should be noted that fatigue in ropes is also frequently caused by vibration and whipping, and it is poor economy to try to eliminate all fatigue at the sheaves if at the same time severe fatiguing action is being set up elsewhere.

The impossibility of setting up any universal standards for sheave and drum diameters is apparent. To attempt to say what a sheave diameter should be for any given size and construction of rope merely complicates a problem that cannot be intelligently solved without considering many factors, a few of which have already been touched upon. Representative averages based on drum and sheave sizes being used on elevators, dredges, derricks, cranes, mine hoists, and certain other equipment are given in Table 2, while Table 3 gives diameters below which rope operation generally will be found unsatisfactory because of the greatly shortened life of the rope. Since the figures given in Tables 2 and 3 are based on average data, they should not be used uncompromisingly in design, but should serve only as a guide.

The sliding of the strands of a wire rope over each other accounts for the flexibility of the rope and for its ability to handle heavy loads in severe service. There is a certain minimum bending radius below which the strands of a rope clamp each other in a vise-like action, causing the strands to lose their independence of motion. This diameter, known as the critical diameter, marks the sheave size below which the rope strands cannot slide past each other

TABLE 5—LEAD LINE PULL FACTORS AND EFFICIENCIES FOR HOIST OR FALL ROPES

Number of Parts of Rope	2	3	4	5	6	7	8	9	10
Efficiency, per cent	96.15	92.45	88.89	86.48	82.19	79.03	75.99	73.06	70.25
Lead Line Pull Factor, per cent	52.0	36.05	28.12	23.39	20.27	18.07	16.45	15.21	14.23

(The stress in the lead line equals the load multiplied by the lead line pull factor.)

TABLE 6 — SAFE UNIT BEARING PRESSURES OF ROPES ON VARIOUS MATERIALS IN SHEAVES

(Lb. per sq. in.)

	Regular Lay Rope				Lang Lay Rope			Remarks
	6x7	6x19	6x37	8x19	6x7	6x19	6x37	
Wood	150	250	300	350	165	275	330	On end of grain of beech, hickory, gum.
Cast Iron	300	500	600	700	350	550	660	Average Brinell Hardness of 160.
Carbon Steel Casting	550	900	1075	1250	600	1000	1180	.30–.40 Carbon; Average Brinell Hardness of 160.
Chilled Cast Iron	650	1100	1325	1550	715	1210	1450	Not advised unless surface is uniform in hardness.
Manganese Steel	1500	2500	3000	3500	1650	2750	3300	Grooves must be ground and sheaves balanced for high-speed service.

to adjust themselves to the bend, resulting in excessive internal stresses. Ropes operating over sheaves of such small diameters go to pieces quickly. These diameters are given in Table 4.

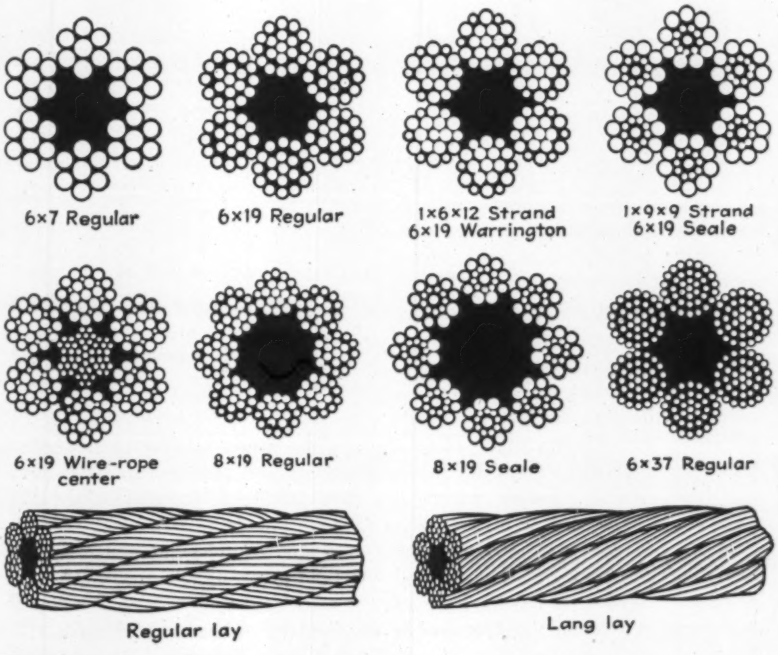
Effect of small sheaves

There are cases where the sheaves and drums are so limited in size by unavoidable restrictions that the only possibility to reduce rope fatigue lies in reducing the size of the rope or changing its construction. Rope size can be reduced by using sheaves or tackle blocks at some fixed point and at the load, and reeving the rope through these blocks in several parts. This greatly decreases the lead line pull, not exactly in proportion to the number of rope parts, but in accordance with the factors given in Table 5, which also gives the efficiency of the tackle equipment. This solution, however, requires that the drum capacity be increased to take care of the increased length of rope; and, to maintain the same rate of load travel, the peripheral speed of the drum must be increased in proportion to the number of rope parts.

TABLE 7 — PROPER GROOVE DIAMETERS

Nominal Diameter of Rope	Tolerance of Groove Diameters	
	Min.	Max.
½ in. and smaller	+1/32 in.	+3/32 in.
9/16 in. to 1 in.	+1/16 in.	+⅛ in.
1-1/16 in. to 2 in.	+3/32 in.	+3/16 in.
Over 2 in.	+⅛ in.	+¼ in.

Another solution to the problem is to omit the tackle blocks and to employ two or more ropes in parallel, each attached to the load independently of the other ropes, or through equalizing bars or equalizing sheaves. The rope speed, in this case, is the same as with a single rope, but the rope diameter is decreased and the drum capacity increased as in the case where tackle blocks were considered.


6×7 Regular
6×19 Regular
1×6×12 Strand 6×19 Warrington
1×9×9 Strand 6×19 Seale
6×19 Wire-rope center
8×19 Regular
8×19 Seale
6×37 Regular
Regular lay
Lang lay

Constructions of typical wire ropes. Most common is 6x19 type but where more flexibility is needed a 6x37 type is indicated.

Material of drums and sheaves

The material used for sheave and drum treads has an important bearing on the service obtained from the rope as well as from the sheaves and drums. The maximum unit radial pressures of the rope on the drum or sheave can be determined from the formula:

$$P = \frac{2T}{dD}$$

where P is the unit pressure of the rope on the drum or sheave, in lb. per sq.in.; T is the rope tension in lb.; and d and D are diameters, in inches, of rope and sheave respectively.

By comparing the value of P with the safe unit bearing pressures on various materials (Table 6), a proper sheave material may be selected.

Positioning of sheaves

Wherever possible, sheaves and drums should be so positioned as to avoid reverse bends, since a reverse bending action is very favorable to the development of fatigue and is therefore highly destructive to ropes. If a reverse bend cannot be avoided, the sheaves should be a considerable distance apart, allowing a long length of rope between adjacent bends, and the sheave diameters should be increased if possible. Such measures will counteract much of the destructive action of reverse bending.

Sheaves should be mounted in perfect alignment; otherwise excessive wear of both rope and sheave will occur. The lead from a sheave to a winding drum should be as long as practicable in order to keep the fleet angle small, thereby preventing rubbing of the rope on the sides of the sheave groove. A large fleet angle also often results in uneven winding and piling of the rope on the drum. Where space permits, a lead of 40 ft. per foot of drum fleet is desirable.

The design of the grooves of drums and sheaves is important, since the size and contour of the grooves may greatly affect the life of the rope. Good design demands that the grooves be slightly oversize compared with the diameter of the rope, and yet not so large as materially to reduce the bearing surface of the rope on the groove throat. In grooving a drum or sheave, one should keep in mind that the diameter of a rope when new is slightly larger than its nominal diameter. If grooved diameters are machined equal only to the nominal diameter of the rope, the rope will be pinched by the sides of the groove until it has had time to seat itself by wearing the groove. Such pinching is highly destructive to rope.

Table 7 gives the tolerance of groove diameters for the complete range of rope sizes. Grooves made according to these specifications will allow ropes to work freely, even though the ropes be slightly oversize in accordance with manufacturing tolerances.

Selecting the rope

After all questions of drum and sheave design have been settled careful consideration should be given to the roping of a machine. Rope constructions should be selected that best meet the individual situation. The most popular construction is 6x19 (6 strands of 19 wires each), since such a rope performs satisfactorily under most situations. Where sheaves are very small, however, a more flexible rope such as 6x37 may be desirable. Flexibility may also be increased by using preformed rope, or rope of Lang lay construction. Preforming also eliminates the tendency of wire rope to kink. Where abrasion is a serious factor, Lang lay rope is generally most serviceable. Situations also arise in which heavy loads cause a severe distortion of the rope where it passes over sheaves and drums, in which case a wire-center rope is recommended to provide greater resistance to crushing.

Eccentric-Load Formula

DAVID B. HALL

Designer, Ash-Howard-Needles & Tammen, New York, N. Y.

COMPRESSION in unreinforced concrete or masonry shafts, eccentrically loaded, is figured by assuming a linear variation of compressive stress over all or a portion of the area, and adjusting it so that the loads and stress are in equilibrium. Although students of elasticity or soil mechanics will recognize that it is only a crude approximation, this same procedure is also commonly extended to determine the masonry pressure under columns or bridge shoes, and the foundation pressure under footings.

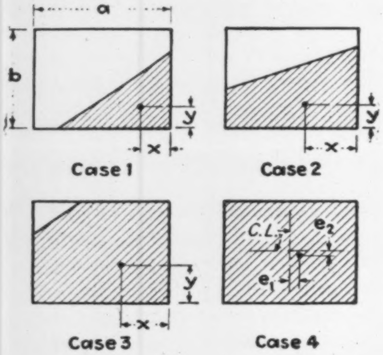


Fig. 1. Valves of coefficient in unit stress formula for various locations of resultant load. Numbered areas correspond to cases of loading illustrated in Fig. 2.

When the load on a rectangular section is eccentric in two directions the mathematical treatment may become somewhat complicated. The problem resolves itself into finding a formula in terms of (a) a few readily determined dimensions, and (b) a factor as nearly constant as practicable, obtained from a table or diagram.

The following equation has been found to comply with these requirements:

$$f = \frac{C\,P}{x\,y} \qquad (1),$$

where f is the unit stress at the corner nearest the resultant load; C is a factor depending on the location of the resultant load, with values mapped on the rectangle in Fig. 1; P is the resultant load, and x and y are the coordinates of the resultant load measured to the nearest corner. It will be observed that in the area outside of the kern the factor C varies only from a maximum of 0.375 to a minimum of 0.333. Thus for ordinary purposes a constant value of 0.375 could be used with a maximum error of $12\frac{1}{2}$ per cent. A very high degree of accuracy can be attained by simply estimating the location of the resultant load on the diagram in Fig. 1.

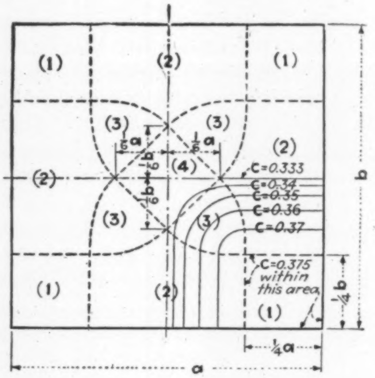


Fig. 2. Four typical loaded areas on a concrete section showing position of resultant load.

The kern of a section is the area in which a load must be applied to produce compression over the entire area. For a rectangle it is the area bounded by lines joining the third points of the main axes. Within this area the factor in Eq. (1) becomes more sensitive, attaining a minimum value at the center, where

$$f = \frac{P}{A} = \frac{1}{4}\,\frac{P}{xy}.$$

The factor has not been mapped for this area, and it is recommended that the conventional formula,

$$f = \frac{P}{A}\left(1 + \frac{6e_1}{a} + \frac{6e_2}{b}\right) \qquad (2),$$

will be more satisfactory, where e_1 and e_2 are the eccentricities measured parallel to the dimensions a and b respectively.

No attempt has been made in this article to provide means for locating the neutral axis, which is also the boundary of the area of contact, but the limits of the four possible cases have been shown in Fig. 1.

Tremie Concreting Scheme Simplifies Foundation Job

W. F. Way

Vice-President, Stuart Cameron & Co., Ltd.
Vancouver, B. C.

***Contents in Brief**—Rock in a bridge-pier foundation subject to erosion was given a protective concrete armor placed through tremies by a method devised to avoid either horizontal joints between successive pours or dangerous stresses in forms large enough to support the entire mass of fresh concrete.*

A SUBAQUEOUS CONCRETING PROBLEM was involved in placing 750 cu.yd. of concrete at the base of a bridge pier at the Ruskin power plant in British Columbia where the rock was subjected to severe erosion from water flowing in the spillway. The method devised to place a protective coating of concrete economically and effectively is described in the following.

The pier had been constructed seven or eight years before the present operation was begun, and during that period the supporting rock was frequently subjected to the erosive action of swift currents in the spillway through which water flows over the Ruskin dam immediately above the bridge. The repair work could be done in still water but there was no way to avoid placing concrete in depths ranging up to 27 ft.

Two methods of construction were considered. One, patterned along the orthodox lines, was to build a heavy, weighted form along the outside boundary of the armor and to pour the concrete behind this form in horizontal layers. Objections to this method were difficulty of anchoring the form to the steep rock face so that there would be equalized stress distributions in the anchors. Moreover, either heavy form stresses would result from a continuous 750-cu.yd. pour, or objectionable horizontal joints would be made by placement in successive pours.

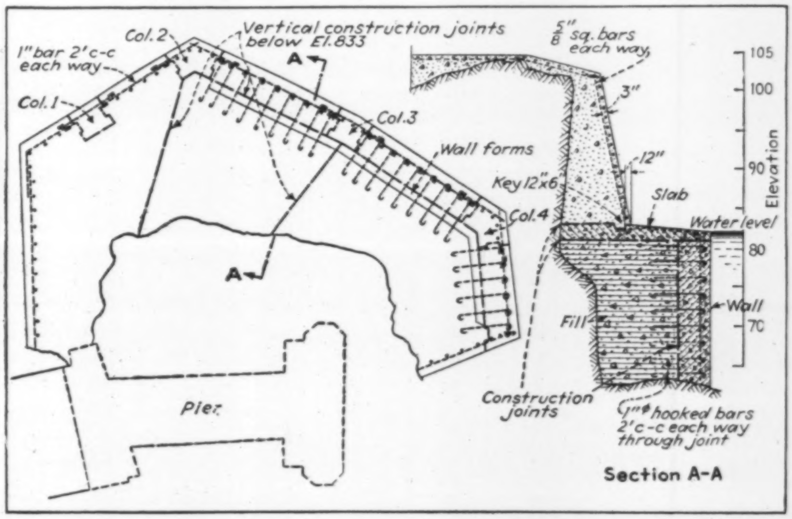
A better method, which was successfully applied, consisted in first pouring columns and walls that constituted the outer portions of the concrete armor and also served as forms to retain the bulk of the yardage. This method logically divided itself into five successive steps.

The first step was to rigidly attach to the rock at water level a floating template whose outer edge was shaped to the outline of the protective concrete at water level. The template was buoyant enough to support several men and thus served as a working platform from which careful soundings were taken, checked by divers. (During pouring, water level was maintained at a constant level, El. 81, to assure the stability of forms supported by the floating template.)

The second step was to fabricate timber column forms and assemble reinforcing steel in them. Each of these assemblies then was placed as a unit by a locomotive crane operating from the bridge. Sufficient ballast was used to keep each unit upright. When in place, tops of these column forms were rigidly attached to the floating template.

In the third step tremie concrete was placed in the four columns located as shown in the accompanying drawing. Sections of 7-in. steel pipe, supplied from a hopper, were used as a tremie. To shorten the tremie pipe as the pour progressed, delivery was stopped for a few minutes, the tremie was lowered to retain the charge, one of the short sections next below the hopper was taken out and the tremie was raised and reconnected.

To avoid unnecessary form stresses in the deepest column, No. 4, which was 27 ft. deep, it was poured in two lifts. After pouring the first 5 ft. the tremie was shifted to column No. 3, which was poured in thirty minutes without lifting the tremie from the bottom—that is, the concrete was "boiled up" the full 20 ft. in height. Columns No. 1 and No. 2 then were similarly filled and finally the tremie was shifted back to column 4 before initial set had occurred. After stripping, no evidence visible to the diver was found to indicate the location of the construction joint in column 4. The concrete plant consisted of a 1-cu. yd. mixer, a concrete pump and a 7-in. delivery line. The mix was 7 bags of cement (87½-lb. Canadian bags) 4.1 cu.ft. of fine sand, 13 cu.ft. of coarse sand, and 14 cu.ft. of gravel in sizes ranging up to 1½-in. Average slump was 6 to 7 in. These proportions were made to give a very pumpable mixture by bringing in fines that had a



Plan and section of concrete armor placed by tremies around bridge pier at the Ruskin power plant in British Columbia.

high percentage in the lower brackets of sieve analysis. That is, 38 per cent passed through a No. 28 screen, 12 per cent through a 48 screen, and 4 to 5 per cent through a 100 screen.

Wall forms fitted to rock

While the columns were being poured the fourth step was begun; all reinforcing steel and the wall forms to fit in between the columns were placed. The bottom of each wall form had been cut to fit the rock contour and after the column forms had been stripped, columns served as guides for sliding wall forms down into place. Pouring the wall forms, including shallower sections at both ends, where wall and fill were both made in one pour, completed step four.

When inside wall forms could be stripped, a bulkhead was placed from column 3 to the rock, thus dividing the larger part of the fill into two sections to permit of two pours. In these two pours the tremie pipe was placed first in the deepest part.

In addition to work on the bridge pier, 940 cu.yd. of tremie concrete was placed just downstream from the dam to repair rock eroded from the spillway. Here concrete was placed in stepped sections in water ranging from 10 to 65 ft. deep using much the same method and equipment as already described except that the delivery pipe was suspended from an overhead cable. The diving crews who did much of the subaqueous work, such as cleaning the bottom, placing anchors for forms and calking around the contact line between forms and rock, are entitled to much credit for the success of the job.

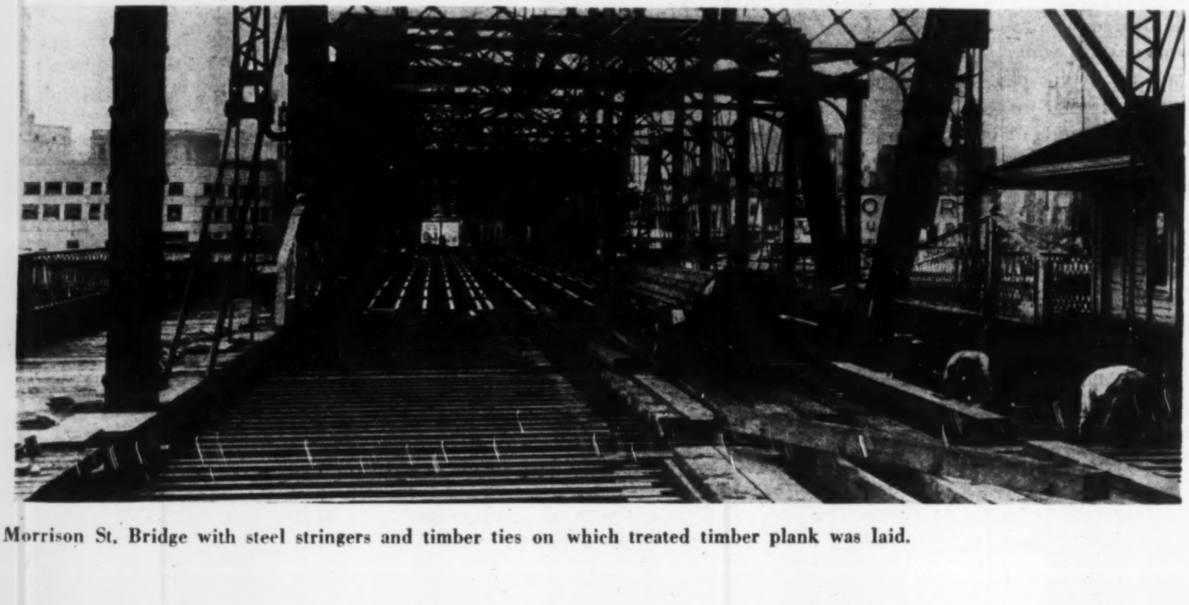
The work was done under the supervision of E. E. Carpenter, consulting engineer, B. C. Electric Railway Co., for whom H. Irvine was resident engineer. The contract was carried out by Stuart Cameron & Co., Ltd., Vancouver, B. C., under direction of the writer; Angus Matheson was superintendent.

Redecking an Old Bridge With Treated Timber

***Contents in Brief**—The 35-yr.-old Morrison Street Bridge in Portland, Ore., after having had numerous deck renewals, was recently given a treated-timber deck whose probable period of service equals the life expectancy of the structure. Lag screws hold planks where spikes previously failed.*

THE MORRISON STREET BRIDGE across the Willamette River in Portland, Ore., was built in 1904 to carry electric railway tracks as well as pedestrian and vehicle traffic. Its timber deck has been renewed several times and just recently was entirely reconstructed in such a way as to embody all the advantages that have developed from long observation by Portland officials of timber floors in bridges. As now rebuilt the floor system is expected to last until the need for increased bridge capacity necessitates rebuilding the steel structure itself.

Until 1921 the wearing surfaces of the deck consisted of transverse planks. At that time the floor system was redesigned for an asphalt pavement and, as the steel stringers were light, 6x9-in. timber crossties were placed on 16-in. centers to distribute load concentration somewhat. To these ties 4-in. planks were spiked and on top was placed a 2-in. single-course asphaltic concrete pavement.



Morrison St. Bridge with steel stringers and timber ties on which treated timber plank was laid.

The completed surface, with 2 in. of asphalt over longitudinal planking.

This construction developed the difficulty that loads caused the stringers to deflect just enough to pull the spikes and loosen planks in the floor, thus cracking the pavement. Surface water entering through these breaks caused decay in the planking and hastened pavement disintegration.

For these reasons the untreated timber deck that had been placed in 1932 was in bad condition in 1938 when a PWA grant was obtained in October for complete reconstruction of bridge deck and approaches. This afforded an opportunity to modernize fully the floor system design and to use treated timber exclusively in the new floor system on the steel spans. Treated timber was estimated to increase the cost about 20 per cent.

The bridge has a 384-ft. swing span and three other through trusses (making a total of 1,092 ft. in steel spans over the channel) plus two timber trestle approaches. In the recent modernization job the relatively short west approach, 172 ft. long, was converted into an earthfill, with the aid of retaining walls, and was paved with concrete. The 411-ft. trestle that constitutes the east approach was given much the same deck treatment as in the steel spans. In the pile bents that support this approach, caps and stringers are untreated. With treated timber in a tight deck above them and with good ventilation, life expectancy in caps and stringers was considered adequate with untreated timber.

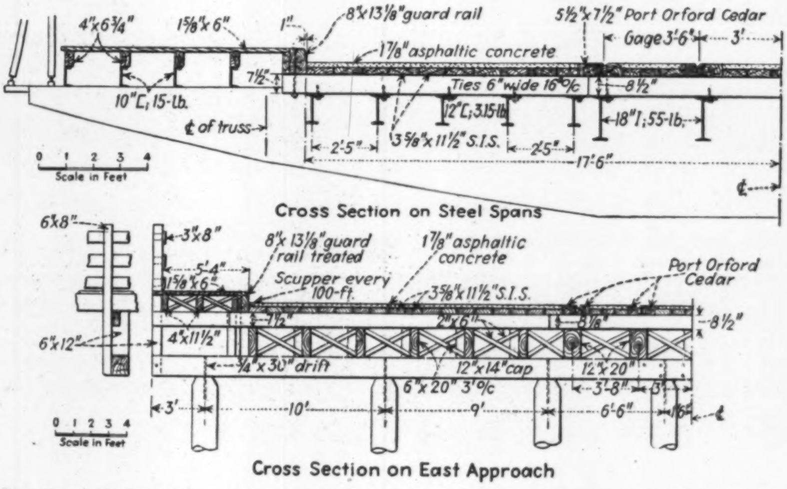
All timber for the new deck, totaling 463,000 fbm., was given an 8-lb. empty cell pressure treatment using a 50-50 mixture of creosote and petroleum oils. The rows of ties on either side of the central portion of the deck were tapered from $8\frac{1}{2}$ in. at the edge of the center strip to $7\frac{1}{2}$ in. at the curb line, thus giving crown to the roadway. The center strip, 15 ft. wide, carrying the car tracks, was laid level.

To give the deck structure rigidity, ties on the east approach were fastened to the stringers with $\frac{1}{2}$x13-in. lag screws. On the steel spans ties were held down with $\frac{1}{2}$x5-in. lags through $\frac{3}{8}$x4x4-in. steel plate washers which engaged the upper flanges of the stringers. Holes were not bored in the ties before treatment as they could not be predetermined with sufficient accuracy. The boring was done with air drills whose bits had a countersink attachment that made the completed hole in one operation. The lag screws were then driven with the same drills equipped with a chuck fitting the heads of the lags.

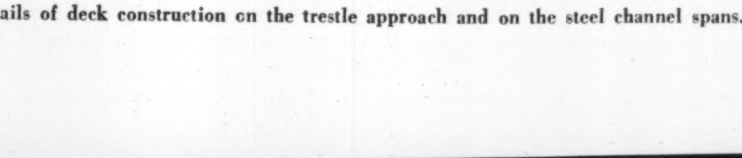
Floor planks, $3\frac{5}{8}$x12 in. in section, were cut to exact length at the mill and holes for lag screws were bored before treatment. The use of lag screws followed an experiment which showed that they eliminated a serious difficulty with spikes working loose in planking under pavement. Two $\frac{3}{8}$x7-in. screws were put in the ends of each plank; elsewhere one screw per tie, staggered. The bored holes were made $\frac{1}{16}$ in. undersize and the heads were not countersunk. As the screws were driven home the planks could be seen to draw into position and bearing, thereby overcoming any tendency to looseness resultant from small differences in thickness.

Asphalt pavement

The pavement is an asphalt base course $1\frac{1}{2}$ in. thick with a $\frac{1}{2}$-in. nonskid wearing surface. Maximum aggregate size in the base course is $\frac{3}{4}$ in. and to make it as flexible as possible in cold weather an "E" grade asphalt with a penetration of 101-



Cross Section on Steel Spans



Cross Section on East Approach

Details of deck construction on the trestle approach and on the steel channel spans.

120 was used; the asphalt proportion (by weight) was about 6 per cent. In the wearing surface the maximum aggregate size was ½ in. with which 5½ per cent of RC4 cutback asphalt was used. Prior to laying the base the entire planked area was sprayed with a coat of "E" grade emulsified asphalt to improve bond between plank and pavement. After evaporation had taken place the sprayed coating appeared to adhere very satisfactorily to the plank which had been laid rough-side up.

Average traffic across the bridge is about 21,000 vehicles per day, of which some 3,700 are commercial type, some with heavy load concentration.

Information for the foregoing was obtained from A. R. Fairbank, engineer, Multnomah County Highway Dept. The redecking was carried out under the direction of Geo. W. Buck, roadmaster. The contract, which was for $93,770, was held by the Parker-Schram Co., Portland; creosoted lumber was from the Pope & Talbot Lumber Co.'s plant at St. Helens, Ore.

Fast Erection of Building Trusses

***Contents in Brief**—Rapid erection of three trusses to carry eight stories over a large open showroom in Tiffany's new building in New York was accomplished by setting lower chord, web members and upper chord in sequence. The design was worked out to facilitate erection as well as to provide simple and efficient details, and fit was assured by assembling and drilling the trusses and columns in the shop.*

THREE 106-ton trusses designed to carry eight stories of building over a large open showroom in the new Tiffany Building, 57th St. and 5th Ave., New York City, have just been erected in the unusually short time of five working days. This was accomplished by setting the three elements of each truss—lower chord, web members and upper chord—in place in sequence, the lower chord member being supported by timber posts at the main joints. The design was worked out to facilitate this erection procedure, as well as to give simple and efficient details; good fit was assured by assembling each truss complete in the shop and drilling all connection holes from the solid.

The trusses span a showroom 85x100 ft. occupying most of the first floor of the jewelers' new store. Despite the heavy sections of the truss members, good details were obtained by making the body of each member a 14-in. H-section supplemented by cover plates on the flanges, and interleaving the gusset plates with the covers. Double gusset plates were required at most of the joints (two ¾-in. gussets on each flange, or a total gusset plate thickness of 3 in. at the principal joints).

As the trusses occupy the full depth of the second story, and in fact extend below the second floor to the suspended ceiling over the showroom, passageways through the trusses were required. The position and web arrangement of the trusses made it readily possible to provide a communicating door and a corridor opening through each truss, as indicated in Fig. 3.

The heavy supporting columns of the trusses had to be placed about 2½ ft. inside the building lines because of the required width of footing grillage. For this reason the wall columns resting on the ends of the trusses and carrying the upper story walls are offset 15 in. outward of the columns below. To avoid an eccentric connection the end member of the truss would have had to be sloped outward, but, as this was considered undesirable because of the heavy splice required at the level of the lower chord, an eccentric connection was adopted as the simpler solution. The moment due to the eccentricity is divided among the three truss members meeting at the upper joint in proportion to their rigidity.

The upper-story columns are seated on the machined edges of the gussets, which extend slightly above

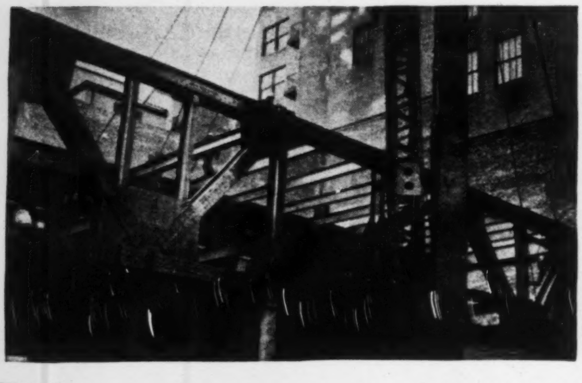


Fig. 1. One of the heavy trusses of the Tiffany Building fully erected after lower chord was supported on timber posts.

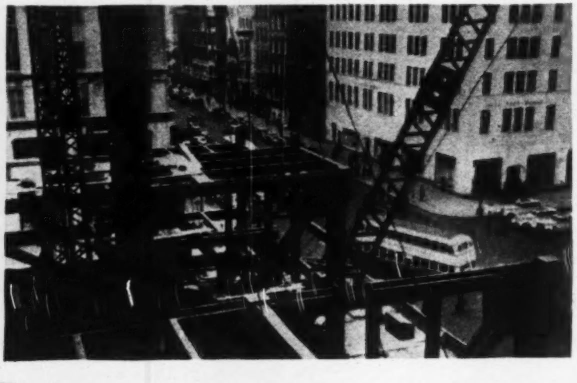


Fig. 2. Two of the 106-ton trusses erected; the third is to be placed midway between them. Top chord is at third-story level.

the general top chord level to provide the seat. The gusset plates are generally two ¾-in. plates on either flange of the H-core of the member, placed next the core. Thus they interrupt the inner two cover plates in each instance, while the outer cover plates continue across the gusset. The two gusset plates being of different size, the joints between cover plates and gussets could be staggered so that splicing for only one joint was required, which is provided by a single outer splice plate. The arrangement is shown typically in the detail sketch of the end joint of the upper chord in the accompanying drawing, Fig. 3.

This sketch also brings out the fact that it was necessary to enter the end gussets, which are shop-riveted to the top chord, between the cover plates of the columns. To facilitate this entry the H-core of the top chord is slightly heavier and therefore wider than those of column and web member; thus ⅛-in. clearance is obtained for easy fit of the gussets over the column and web cores. Clearance between the gussets and the outer cover plates is assured by leaving open two rows of rivet holes just below the splice in each of these two members, thus allowing the covers and splice plates to spring out enough for easy entry of the top chord assembly.

As also shown in the sketch, the billet footing of the third floor column has its seat on the upper edges of the gusset plate. At the seat these plate edges were ground true and smooth to receive the billet, and the latter was then welded in place for shipment by a light bead along the outer edges of the gusset. For the purpose of holding the third story columns, and the billet to the truss assembly, the three parts are riveted together through angle clips.

Trusses erected in five days

Erection of the heavy trusses was handled by a 40-ton guy derrick set in the center of the first floor, on blocking supported by shores below. The end columns of the first truss were set in place on the basement columns, previously erected, and then the bottom chord assembly was entered between the column gussets and supported by timber posts at the main joints. Next the individual web members were pinned and bolted to the bottom chord, and finally the top chord assembly set in place. Bottom chord, webs and top chord came to the site as separate truckloads from the railroad yard. Riveting followed immediately after erection.

Top chord weighs 38 tons

The top chord, heaviest piece because of the large end gussets and column seat billets, weighed 38 tons. Each truss as a whole (including the column section within the truss height) weighs about 106 tons. In handling the top chord member, which on cars and trucks was lying on its back, care was necessary in rolling it a half turn for hoisting to place, this being done on blocking on the street alongside the truck.

For each truss the placing of bottom chord, webs and top chord was generally done on successive days, but as the work on the three trusses overlapped only five working days were required for erection of the three trusses.

Cross & Cross are architects for the Tiffany Building. The framework and foundations were designed by Weiskopf & Pickworth, consulting engineers. The general contract for the building is in the hands of the Turner Construction Co. Fabrication and erection of the trusses were done by the Bethlehem Steel Co.

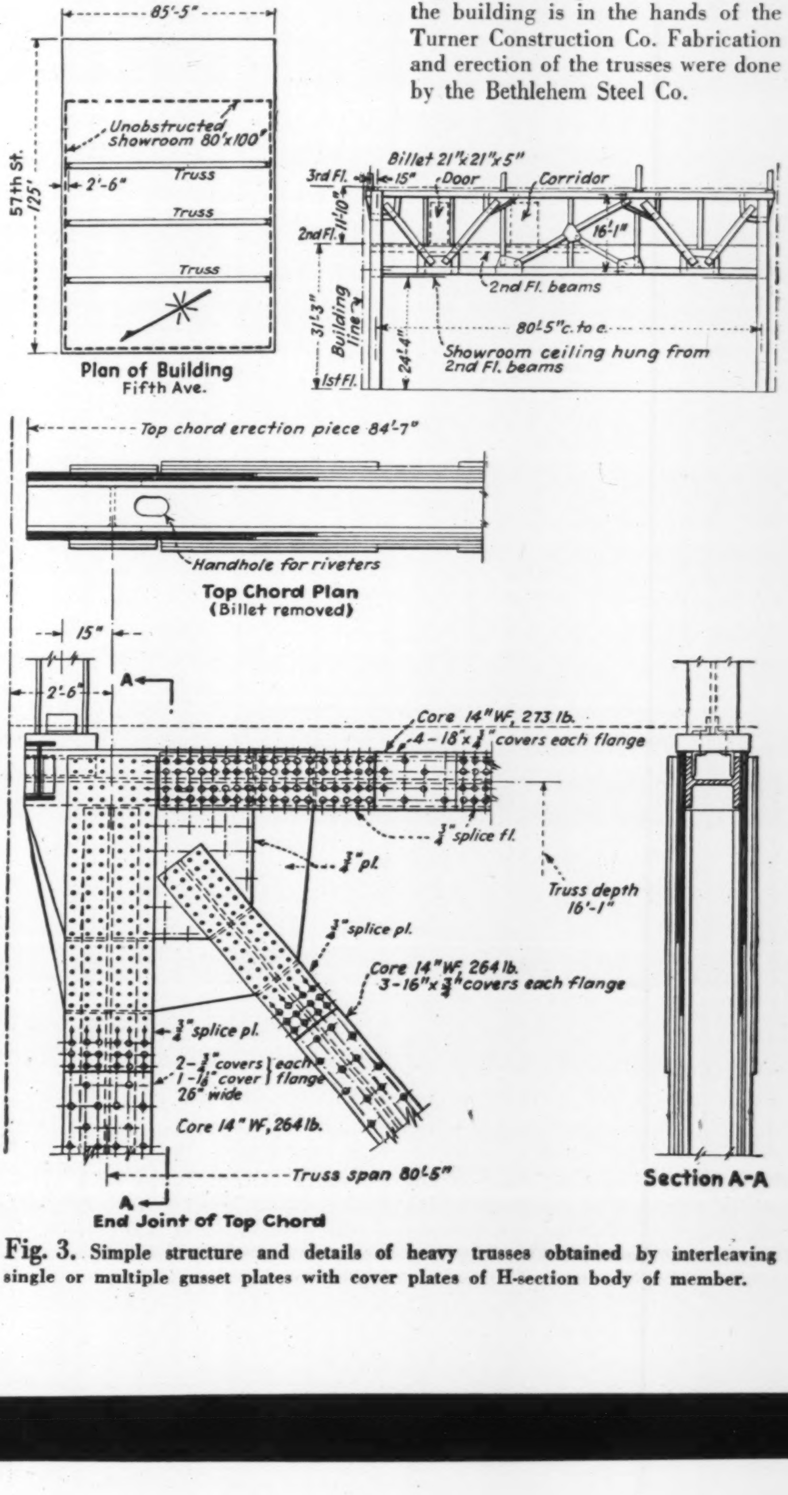

85'-5"
Unobstructed Showroom 80'x100'
57th St. 125'
2'-6"
Truss
Truss
Truss
Plan of Building
Fifth Ave.
Billet 21"x21"x5"
3rd Fl.
15"
Door
Corridor
11'-10"
2nd Fl.
16'-1"
2nd Fl. beams
31'-3"
Building line
80'-5" c. to c.
24'-4"
Showroom ceiling hung from 2nd Fl. beams
1st Fl.
Top chord erection piece 84'-7"
Handhole for riveters
Top Chord Plan
(Billet removed)
15"
2'-6"
A
Core 14" WF, 273 lb.
4 - 18"x ¾" covers each flange
¾" splice fl.
¾" pl.
Truss depth 16'-1"
¾" splice pl.
Core 14" WF, 264 lb.
3-16"x ¾" covers each flange
¾" splice pl.
2-¾" covers } each
1-1⅛" cover } flange
26" wide
Core 14" WF, 264 lb.
Truss span 80'-5"
A
End Joint of Top Chord
Section A-A

Fig. 3. Simple structure and details of heavy trusses obtained by interleaving single or multiple gusset plates with cover plates of H-section body of member.

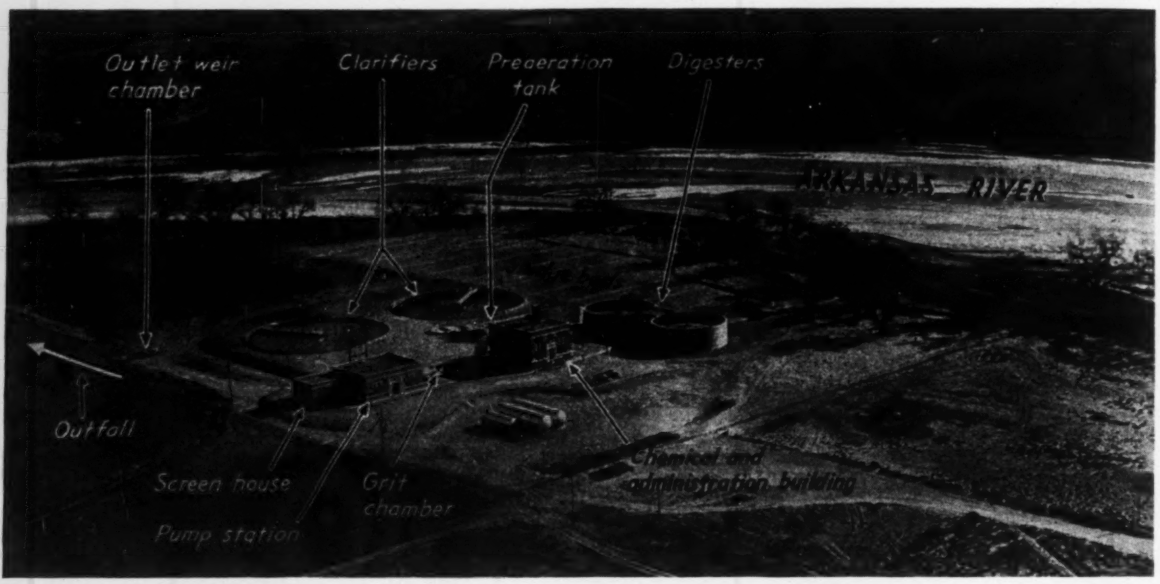


FIG. I. PUEBLO, COLO., PLANT FURNISHES PARTIAL TREATMENT AND THE RIVER DOES THE REST.

Sewage Treatment Coupled with Irrigation

F. W. Veatch

Black & Veatch, Consulting Engineers, Kansas City, Mo.

***Contents in Brief**—The Pueblo, Colo., sewage disposal plant, which in a semi-arid region, provides partial treatment and leaves final treatment to broad irrigation methods. Butane gas is used to supplement sludge gas as an auxiliary and standby fuel for engine operation.*

THE PRINCIPAL OBJECTIVE of the sewage disposal plant for Pueblo, Colo., is to remove suspended solids to the extent that deposition will not occur in the channel of the Arkansas River or in the irrigation canals fed by the river. For final treatment reliance is placed on the natural means afforded by the existing irrigation systems which constitute an excellent example of broad irrigation. The plant which is designed to treat up to 20 mgd, includes screens, grit chambers, pre-aeration tanks, settling tanks, sludge digesters and sludge drying beds.

Pueblo is essentially an industrial city and an important railroad center with a population of 50,000, located on the Arkansas River 40 miles below the Royal Gorge and immediately above the junction of the Arkansas and Fountain rivers, both of which originate in the mountainous country near the continental divide. The river divides the city about equally so far as area is concerned. The business district and most of the industries are located on relatively low land, north of the river. The development of the higher ground south of the river has been largely residential in character.

The sewer system is constructed on the combined plan and discharges into the Arkansas River, at a point a mile below the mouth of the Fountain River through an 8-ft. circular outfall sewer. Due to the extremely "flashy" character of both rivers the city is particularly vulnerable to floods, a fact which was demonstrated with disastrous effect in 1921, when practically simultaneous floods on the Arkansas and the Fountain nearly wiped out the business district (*ENR* June 16, 1921, p. 1.040.

River control works built subsequent to this disaster include a new river channel which has severed the branches of the sewer system serving the southern section of the city. For several years the sewage of this section has been discharged into the river at several points. The disposal project therefore included the collection of the sewage which originates south of the river and its delivery to the main outfall line which is located on the north side. Due to the unstable nature of the bluffs on the south side of the Arkansas (Fig. 1) and to eliminate the necessity of disturbing the levee which forms the north side of the new river channel river, crossings of welded steel pipe weighted with river clamps were constructed at three points to connect with the existing sewers on the north side.

The dry-weather sewage flow averages 18 mgd or 360 gal. per capita per day. In consequence the sewage is dilute. This condition is due to groundwater infiltration and produces only a small variation between maximum and minimum flows during the day.

The entire flow of the Arkansas River is appropriated for irrigation use and therefore the actual amount of water flowing in a given reach of the river is quite variable and at critical flows is dependent on the program of water delivery to users rather than on the natural flow of the stream. Due to the successive diversions into irrigation canals and to the continual replenishment of the stream by return water or seepage from irrigated land, the effect of the sewage of Pueblo has not been as marked as might be expected in the actual streambed but it has been quite noticeable at times on the irrigated land.

Sewage is taken from the outfall sewer through a diversion chamber equipped with an overflow weir and electrically-operated control gates to duplicate screen chambers, each of which is equipped with a bar screen with ¾-in. spacing. The two screening units are mechanically cleaned and discharge into a common tray which serves a grinder. The ground screenings are discharged into the screen chamber. The screened sewage flows by gravity to the wet well of the pumping station from which it is pumped to the main flume which is set at a level which permits gravity operation of the plant units.

Three gas-engine-driven sewage pumps, each of which operate at from 10 to 14 mgd in accordance with pump speed, have been provided and sludge gas is used for fuel with butane as a standby.

Each of the two identical grit chambers is designed to carry the entire sewage flow but in only one of these chambers has grit removal and washing equipment been installed. From the grit chamber the sewage passes through an open flume to the pre-aeration tank in which diffused air at the rate of 1/46 cu. ft. per gal. of sewage is applied for a period of 10½ min. This aeration tank is intended for continuous application as a grease separator and for use as a mixing tank when coagulant is used.

The aerated sewage is discharged into a feed well which serves two 115-ft. circular clarifiers each of which has a side water depth of 10½ ft. and a capacity of 125,509 cu. ft. When operating in parallel at the design rate of 20 mgd these tanks have a detention period of 2¼ hours and an overflow rate of 965 gal. per sq. ft. per day. The settling tanks are equipped for sludge collection and scum skimming and are of the center-feed, peripheral overflow type. The tank effluent is discharged into the outfall sewer through a weir chamber equipped with a measuring weir of the Cippoletti type.

Two sludge digesters, each of which is 60 ft. in diameter and 27 ft. in effective depth, have a combined capacity of 152,000 cu. ft. or 3 cu. ft. per capita. The tanks are equipped with floating covers and are piped for gas collection and heating. The control piping is so arranged that the tanks may be operated either in series or in parallel but the present plan contemplates operation in parallel. The digestion tanks are heated by

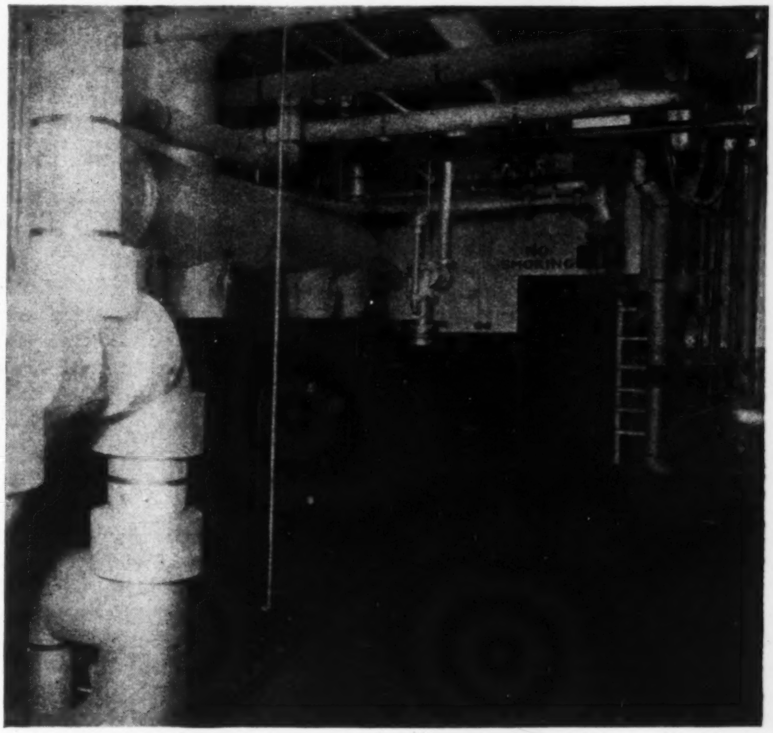


Fig. 2. Boilers for heating service and the circulating water system. A circulating hot-water pump is at the right of the tunnel entrance to the digester control building.

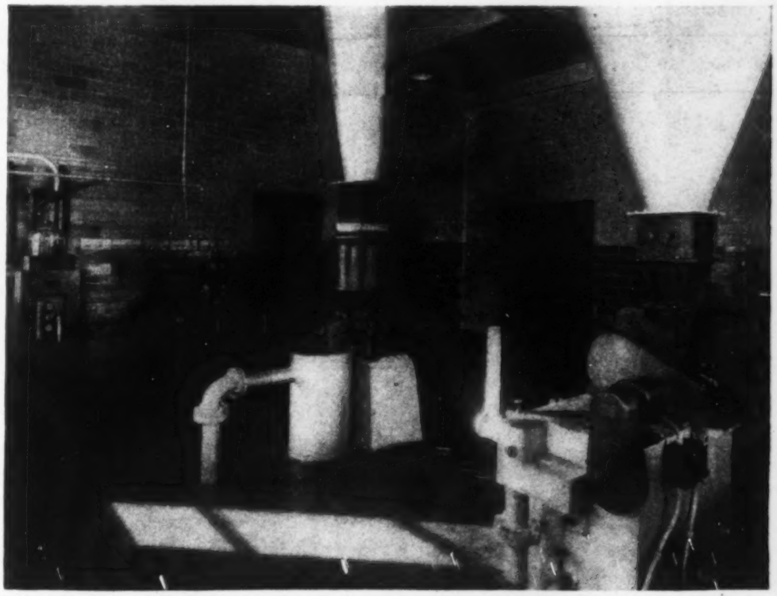


Fig. 3. Chemicals will be used occasionally, for which this equipment is provided. Chlorinators are shown along the wall, and the two dry-feed machines are for copperas and lime.

circulating the jacket water of the gas engines, which for temperature control is passed through the exhaust seat exchangers and a gas-fired heating boiler on its way to the heating coils in the digester and through a cooling coil in the pre-aeration tank on its return to the engines. The temperature of the circulating water is indicated by thermometers set at various points on the circuit and is controlled by hand operation of bypasses around the heat exchangers, the gas-fired boiler and the cooling coil. Two sludge gas storage tanks, each of which has a capacity of 5,000 cu. ft., is operated at 40 lb. pressure. The digested sludge will be air dried on ten undrained sludge beds having an area of 89,300 cu. ft.

The plant was put into operation on Dec. 5, 1938, and was operated on butane gas until March 15, 1939, when the sludge gas became available. Gas production started within 30 days after the digesters were put into use but the carbon dioxide content remained too high for efficient use as engine fuel for a period of 60 days after production started. The use of 2 lb. of lime per 1,000 gal. of raw sludge proved beneficial in improving the quality of the gas.

The contract cost of the project, financed in part through a PWA grant, was $465,300 of which $68,300 was spent for connecting sewers and the remainder for the disposal works. The Schwartz Construction Co. of Colorado Springs, built the connecting sewers and Thomas Bate & Sons, Denver, the disposal plant.

The preliminary engineering work was done by Charles F. Patterson, Pueblo, and plans and specifications were prepared by Black & Veatch, consulting engineers, Kansas City, Mo., who also supervised the work in conjunction with S. F. Elliot, city engineer. All of the project inclusive of the financing was carried out under the general supervision of Paul L. West, city commissioner of health and public buildings.

Land Subdivision Control

Conditions that necessitate public control of private subdivision projects, together with suggested rules and requirements for effective control of such developments, are included in the "Manual of Land Subdivision", issued in the form of a 75-page pamphlet by the City Planning Division of the American Society of Civil Engineers. Some of the principal features of the manual are given in the following abstract. As to the proposed regulations, it is explained that many of them are in use in various cities, so that they are not merely theoretical. It is pointed out that public control is essential to guide the economic development of new subdivisions.

Evidence of the need for control is apparent in most cities. Streets are not continuous or of sufficient width; houses are crowded on small lots although there is abundance of vacant land available; sanitary facilities are inadequate; street grades are severe, and building lots have been plotted on tracts that cannot be used for residential purposes. Too frequently, private initiative has made the welfare of the community subservient to immediate individual gain. The owner is not always the best judge of the public interests involved, and as competent technical talent is not always employed, it becomes imperative for public authorities to supervise subdivision activities with care.

Since the suggested regulations embody normal minimum requirements, it is urged that no subdivision should be accepted unless it conforms to them, while a standard higher than that set by the regulations is desirable. "Much can be accomplished by informing realtors, engineers, surveyors, and others concerned that greater returns are possible by careful study and the planning of the complete subdivision, including the layout and installation of utilities and buildings simultaneously with the division of the tract into blocks and lots. Both extensive and small subdivisions require the services of skilled technicians. There is no substitute for such services."

Numerous expedients have been tried to prevent the premature subdivision of land, but few have been successful in operation. All large cities and some smaller communities suffer from an excess of such subdivision and vast sums of money have been invested in land lots. "The major part of these sums is lost; and yet the subdivision and sale of land continues, leaving disappointed investors and weed-overgrown plots." To curb this type of speculation, the suggested regulations require that all public utilities (including street paving, water mains, sewers and other improvements) shall be installed, or installation assured by an adequate bond, before final approval of the plan. This requirement is considered sufficiently effective to prevent undue exploitation. It does not countenance the continued creation of more vacant lots.

Some authorities favor control by requiring a certification of convenience and necessity, but the manual states that no such certificates are in use. Supervision by public authority is exercised generally by a city planning commission, because it is the custodian of the city plan and therefore possesses knowledge of local problems of land use, transportation and other public considerations affecting public welfare.

• • •

Water Plant Records, New Line, and Operation

That operating records of a water treatment plant are an essential part of proper operation is emphasized in a bulletin on *Practical Procedures for the Water Works Operator*, issued by the Georgia State Department of Public Health and designed particularly for the assistance of operators of the smaller class of plants. Records of filter operation together with pumping cost and upkeep give important information in determining production costs. Records of daily chemical and bacteriological tests are essential.

The relation of record keeping to the efficiency of the operator is also stressed. It is pointed out that in cases of water-borne epidemics, or even in a single case of certain diseases the quality of the public water supply will be called in question.

Monuments for Municipal Surveys

Earle M. Rader
Assistant City Engineer, Miami, Fla.

***Contents in Brief**—In order to establish accurate control lines, Miami, Fla., has been making precise surveys and setting monuments throughout the city. This article describes the field and office methods used, and the manner in which monuments are built and placed in position.*

Monumenting or the establishment of horizontal control lines is one of the troublesome problems with which many municipal engineers are faced. In Miami, for instance, a good part of the present incorporated area was subdivided before the city limits were extended to include it. Many of these subdivisions were filed of record before survey laws were passed by the state legislature and prior to the registration laws for engineers and surveyors. Consequently, there are numerous subdivisions where the surveys and the plats are in error, thus creating overlaps or excess strips. The following description of monumenting practice in Miami, where a good deal of this work is being done, may be helpful to other city engineers.

Miami is located in sectionized territory. The section corners and quarter-section corners (with the exception of the center quarter section marks) were set by U. S. Government surveyors some fifty to one hundred years ago. In making our monumenting studies, therefore, we have for the most part confined each study to a quarter section of land. The first step taken is to verify carefully the four corners of the quarter section. The original corner marks, which consisted of lightwood posts, rockpiles, charcoal pits, etc., have been in all cases replaced by private surveyors' monuments. However, in checking these points we are able many times to find the remains of old witness trees and other government reference points.

Using the quarter section lines as a boundary, a random survey is next made and random lines are run on each street. Fortunately, most of the blocks are rectangular so that very little curvilinear work is involved. All occupation such as buildings, fences, survey markers, stakes, pipes, sidewalks, street improvements, etc., are carefully tied in to these random lines and the whole survey is closed by angles and distances in the field.

After this survey is completed, the notes are turned over to a draftsman who plats the information on a large detail plat to a scale of one inch equals 50 ft. A designer then makes a mathematical closure of the survey as a check on the field work and computes corrections for the random lines in order to establish true monument lines. In doing this, he thoroughly studies county records as to the chains of title involved and looks into subdivision plats of record in order to relate record information with the actual occupation on the ground. After thorough study and comparison of this nature, necessary corrections can be made, through the application of survey laws.

As a safeguard and in order to check computations, a second designer makes an independent check of the corrections. This often leads to some interesting discussions between the designers because, frequently, monument lines could be located in one place on the basis of occupation and in another place by the use of record information. Some of these cases are hard to decide and require, along with a thorough knowledge of surveying law, the application of a certain amount of "horse sense."

Setting the monuments

Following the office work, the random line corrections are given to a field survey party which places the monuments. The field men transfer random line locations so that they become true monument lines, and then they set four straddler points where each monument is to be established. After the monument is placed, the intersection point is accurately determined by stretching cords across the straddler points.

Both permanent and temporary monuments are used, depending on the location. The permanent type shown in Fig. 2 consists of a concrete block cast in place with a brass pipe embedded in the concrete to

Fig. 1. Field work for the monumenting studies is carried out by a survey party of four men. Tapes with a temperature-adjustment scale are used.

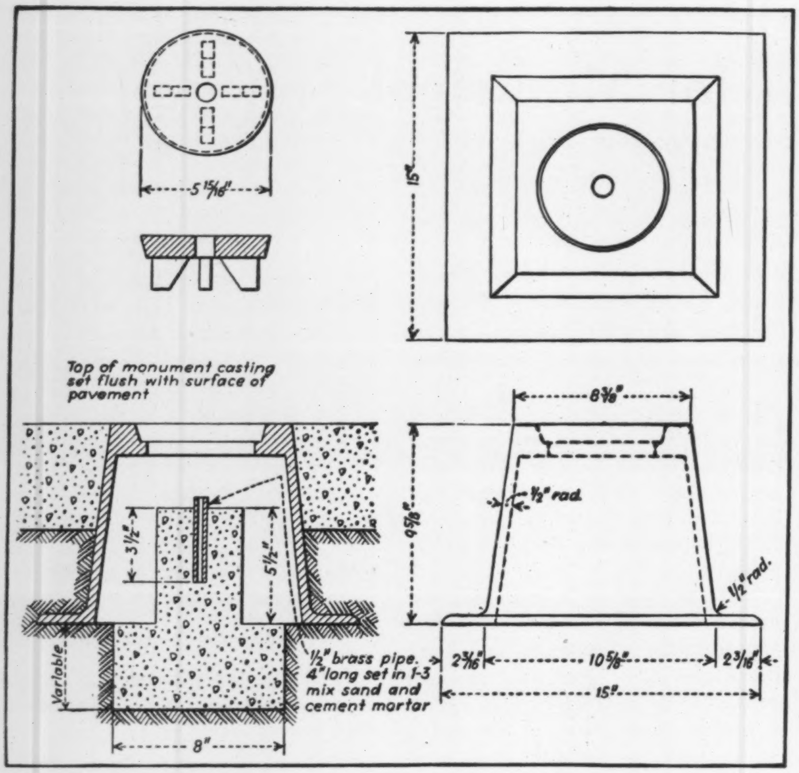

5 15/16"
15"
Top of monument casting set flush with surface of pavement
8 3/8"
1/2" rad.
9 5/8"
3 1/2"
5 1/2"
1/2" rad.
Variable
1/2" brass pipe. 4" long set in 1-3 mix sand and cement mortar
2 3/16"
10 5/8"
2 3/16"
15"
8"

Fig. 2. Permanent monuments consist of a concrete block cast in place and a brass pipe center piece. A cast iron frame and lid protect the monument.

mark the center point. A cast iron frame with a lid giving access to the survey point is placed on top of the monument. Temporary monuments consist of 1¼-in. pipes filled with cement grout and embedded in concrete; a nail is used to mark the center point. Temporary monuments are used in locations where the pavement is likely to be replaced within a few years.

It is customary to locate monuments five feet north of the centerlines of east and west streets and five feet west of the centerlines of north and south streets. The five-foot offset was chosen because manholes generally occupy the centerline intersections of streets. In some cases, where streets vary in width, it is better practice to parallel the land line at a distance of five feet rather than to make a jog in the monument line wherever the street width changes. In the downtown district where traffic is heavy and it is almost impossible to occupy a monument in the street intersection during daylight hours, we have adopted a location one foot from the property line for monument lines. We find that this one foot offset generally allows clear vision for the surveyors, due to the fact that people walking on the sidewalk usually keep far enough away from the buildings to leave an open space.

Each monument is tied-in with reference lines taken to nearby permanent objects or to stakes. Angles and distances are taken to all reference points, and this information is filed in the city engineer's office for the use of all surveyors.

The final field operation consists of making a double measurement of the distance between monuments, and checking the angles of closure. These measurements are taped in opposite directions and averaged for the final recorded result. To insure accuracy the 100-ft. steel tapes are equipped with a temperature adjustment scale. Measurements are taken with the tape suspended, and a spring balance is used to determine proper tension. Past experience showed that there was too much chance for error when temperature expansion or contraction was computed, and this led to the adoption of tapes having temperature scales as standard equipment.

All the notes on the field work are returned to the office where the final measurements and angles are checked with computations to determine whether or not the field corrections have been properly made. This checking includes a mathematical closure, and if the error is beyond the allowable limits, the survey party is again sent into the field to make the proper corrections. Following this a second check is made in the office.

Using the established monument distances and angles as a basis for calculations in each city block, the exact amount of land by actual survey in each lot or parcel is determined. It has been found that in most cases there is some variation, and this must be adjusted through the block in accordance with survey laws and good practice. All this information is plotted on a standard 24 x 36-in. tracing to a scale of one inch equals 50 ft. These maps are used for many purposes. The tax assessor, for instance, finds them invaluable since they show accurately all land and account for any excess property not shown by recorded subdivision plats. The maps are also used for street widening operations, zoning, special assessment computations, and general real estate reference purposes.

Some thought has been given to the advisability of a triangulation survey in Miami, but so far we have not felt the need of such a survey, since our monument line network has been accurate enough for all of our requirements. However, the U. S. Coast and Geodetic Survey has a triangulation net along the westerly shore of Biscayne Bay, and this has been tied into our monument net at various points.

Supplementary information of interest to municipal engineers on the manner of conducting a geodetic and typographic survey will be found in ENR, Sept. 24, 1936, p. 413.

* * *

$1,600,000 for Chicago Bridge Work

For construction of the new Canal St. bridge over the south branch of the Chicago River, the allotment of $1,455,000 from the city's share of the motor fuel tax has been requested by the Commissioner of Public Works. Including repair and maintenance of several existing bridges the total allotment would be $1,602,000 for bridge work in 1940.

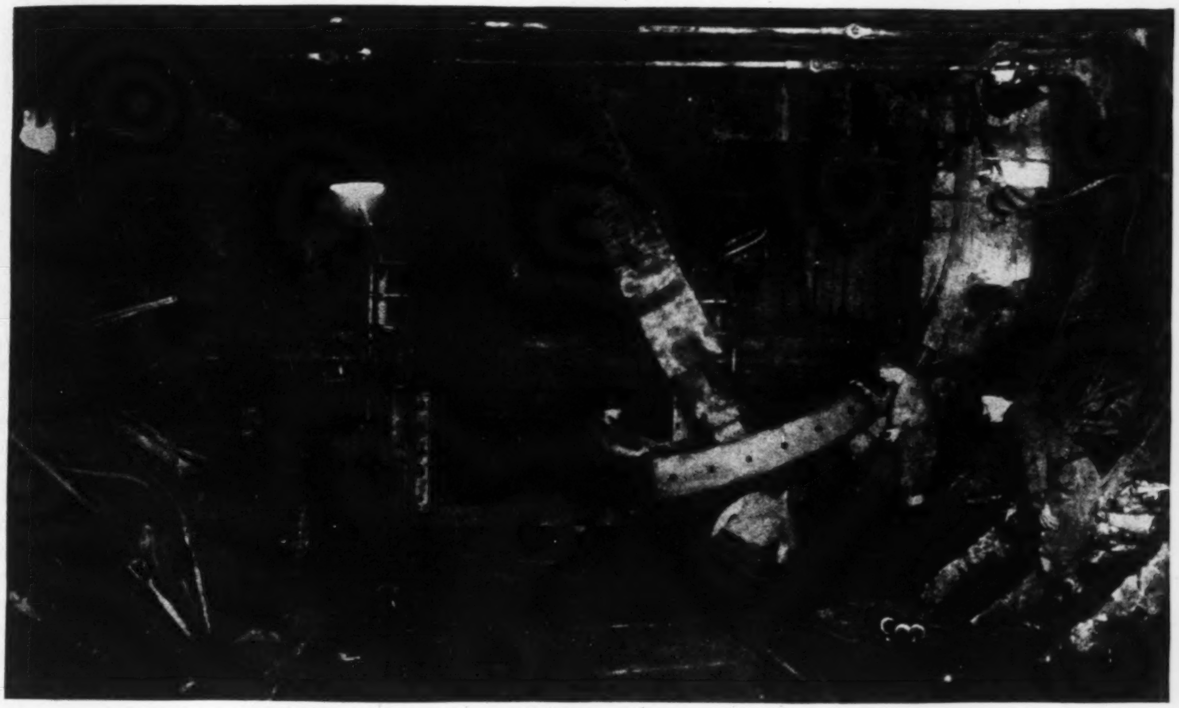


FIG. 1. ERECTOR SWINGS FIRST SEGMENT OF NEW RING TO PLACE IN THE QUEENS MIDTOWN TUNNEL.

Driving the Queens Midtown Tunnel

Contents in Brief—Twin 31-ft. highway tunnels under the East River have been driven successfully through riprap, mud and rock by shield and compressed air, by virtue of unusually skillful face work. Power mucking contributed to speed of driving. Gravel packing and grouting provide firm support for the cast-iron lining. In spite of two critical incidents a high mark in safety was attained, without a single death from bends.

HOLING THROUGH on Nov. 8 after driving two 31-ft. tunnels a distance of nearly 4,000 ft. through rock, earth, mud and riprap, the contractor for the Queens Midtown vehicle tunnel under the East River at New York successfully ended an exceptionally hazardous part of his job. The nature of the ground in combination with the large size of the tunnel made it perhaps the most difficult piece of underwater tunneling ever undertaken, yet it was carried out with unusual safety and ahead of schedule. In design as well as construction, the tunnel represents the highest development of the art.

Details of the design of the tunnel were given in the issue of Dec. 21, p. 830, as was an outline of the planning that led to its construction.

A fast schedule was contemplated from the outset, to provide early traffic relief, hold down interest charges during construction, and comply with PWA requirements. While money was available early in 1936, an attempt to pass legislation at Albany that would have substituted a bridge for the tunnel delayed the beginning of work to late summer of that year. Shaft work was then started on the Queens side, while completion of tunnel design and approach studies continued. Bids on the river work were advertised for on April 14, 1937, but due to the unusual contracting conditions of the time actual work did not start until July 14. Thus the driving of the river tunnels to the point of holing through was accomplished in 28 months, or at an average rate for the 3,989-ft. crossing of over 140 ft. per month for the entire period. Completion of the entire work in November, 1940, as predicted, will mean a monthly average of 100 ft. of completed twin tunnel ready for traffic.

The delay of three months in beginning construction resulted from unusual contract negotiations. Only two bids were received on May 25, 1937, as the result of the official call. The low bid was sufficiently above the engineer's estimate to jeopardize the project on the basis of the money available, while the other bid, by the contractor then building the Lincoln Tunnel, was still higher. As the low bidder's experience in building other subaqueous tunnels of great difficulty was believed to assure the success of the hazardous undertaking, it was not thought best to reject the bids and

Fig. 2. **Giving the lining bolts their second tightening with 5-ft. ratchet wrench. The shield jacks may be seen behind the men.**

readvertise, and therefore negotiations between the low bidder and the Tunnel Authority were undertaken with a view to bringing the price down to a feasible point. A reduction of the bid price of $24,763,515 to $22,680,150 was accomplished by eliminating certain parts of the work from this contract, and a further reduction of about $1,500,000 was agreed upon in the light of other contract modifications, worked out by concessions on both sides. The revised bid was accepted by the Tunnel Authority. On present quantities the payment under the contract is expected to amount to about $22,112,000. Adding the cost of the cast-iron lining ($3,356,000), bolts ($195,000), and tunnel finish and pavement ($500,000), the total cost of the 4,098 ft. of twin tube river tunnel will be about $27,000,000.

Other major items of the project cost bring the construction cost of the project to $40,000,000. The total project cost is expected to be well within the engineers' estimate and the PWA allotment of $58,365,000.

Complex and contorted rock strata standing on edge underlie the bed of the East River. Partly covering them, deposits of glacial clay, mud, sand, man-deposited riprap and débris form the river bottom, which is in two channels separated by a submerged rock reef extending south from Welfare Island. This is the ground through which the twin tubes of the tunnel had to be driven.

Borings spaced about 200 ft., between or just outside the lines of the tunnels, traced out the nature of the bottom to the section shown in Fig. 3. The tunnel profile was so laid as to remain well below top of rock in the submerged reef and below the levels fixed by the War Department at the pierhead line (48 ft. below mean low water at the Manhattan and 43 ft. at the Queens pierhead line). In detail, the rock surface disclosed by the tunneling operations proved to be much more irregular than the expected profile and the work in consequence was more variable, difficult and costly. Tunneling in mixed face—sand or mud above, rock below—is not only more difficult and hazardous than either full earth or full rock face but under the terms of the contract also called for a higher price.

CONTRACT PRICES PER CUBIC YARD OF TUNNEL EXCAVATION

Full earth face	$62.00
Mixed face	96.00
Rock, land section	43.50
Rock, river section	52.50

In the west channel the river bottom dips below the roof of the tunnel on the adopted profile for a short distance. Here a permanent clay blanket was placed, with top at the limiting point fixed by the War Department for permanent bottom, namely, 38 ft. below mean low water at the pierhead line and sloping to depths of 40 ft. and more in the channel. In addition, the full width of both channels required the protection of a clay blanket 20 to 35 ft. thick, proportioned to make its submerged weight exceed the unbalanced air pressure at the top of the shield. In the west channel the maximum combined thickness of permanent and temporary blankets over the original river bed was 50 ft.

This blanket had to be so placed as to maintain a navigation channel at all times, particularly in the west channel, the main route between New York harbor and Long Island Sound. Only half of either west or east channel widths could be blanketed at a time, but close cooperation of the tunnel authorities and the contractor with the War Department overcame all difficulties connected with this operation, without delay to the tunnel. Other local shipping requirements limited the blanketing in the east channel, and here the provision of a new temporary barge basin some distance north of the tunnel facilitated the adjustment of tunnel and shipping demands.

Driving difficulties

A simple, adaptable shield with ample supply of face jacks to hold the breasting; shovel and conveyor mucking; ample air supply at minimum safe pressure; and exceptionally skilled and watchful face operations, were the main elements of the tunnel driving responsible for its success.

From the boring record and soil investigations, it was expected that maximum pressures up to 43 lb. or more would be needed at the points where the shield met or left rock, to balance the hydrostatic head at the bottom of the cutting edge. However, the work went through with a maximum pressure of 37½ lb., and usually in soft ground the equilibrium level lay between the center line of the tunnel and 10-ft. below center line.

As much porous ground was sure to be encountered, the engineers specified and the contractor provided

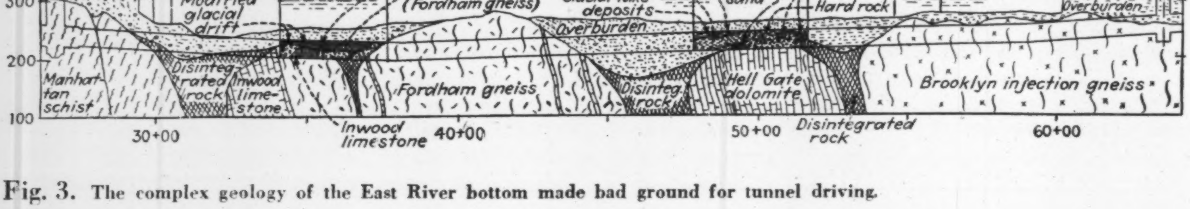

3,989' on center line between tunnels
South tunnel
C.L. Vent shaft
Overburden
U.S. Pierhead line
Modified glacial drift
As found in driving tunnel
Water
Decayed rock
Hard rock (Fordham gneiss)
Modified glacial drift
Glacial lake deposits
Overburden
As found in driving tunnel
Silt and sand
Decayed rock
Hard rock
U.S. Pierhead line
U.S. Bulkhead line
C.L. Vent shaft
Overburden
300
200
100
Manhattan schist
Disintegrated rock
Inwood limestone
Fordham gneiss
Disinteg. rock
Hell Gate dolomite
Brooklyn injection gneiss
30+00
Inwood limestone
40+00
50+00
Disintegrated rock
60+00

Fig. 3. **The complex geology of the East River bottom made bad ground for tunnel driving.**

an unusually large and complete air plant, one of the largest ever set up for tunneling work. A plant capacity of 45,000 cu. ft. per min, of low pressure (50-lb.) air was required on each side of the river, counting 80 per cent of the high pressure capacity in this total. Somewhat larger capacity was installed, and in fact at one time a heading was saved only by pumping in air at the rate of 46,500 cu. ft. per min., the full plant on the Manhattan side being concentrated on this single heading.

The Manhattan plant, typical of both, comprised seven low-pressure compressors (5 at 5,770 cu. ft. per min., 2 at 6,040) generally 29 x 29 x 21, with 625 and 660-hp synchronous motors at 2,300 volts; three 150-lb. compressors 25 x 14¼ x 18 in. at 2,000 cu. ft. per min. with 400-hp synchronous motors; three 100-hp pumps of 10,000 lb. per sq.in. capacity for shield jacks operated generally at 5,000 lb. per sq.in., erector and face jacks (table jacks and intermediates); two accumulators and two hydraulic receivers for equalizing the pump impulses. Three independent 13,800-volt feeders supplied the plant, each with its transformer and switches mounted in independent cells. Incoming current was transformed to 2,300 volts for the main machines and through 2,300–220–110 transformers for lights, hydraulic pumps, mucking machines, conveyor and trolley hoists, etc.

Initial operations on the two sides of the river differed somewhat because of different relative location of construction shafts and permanent ventilating shafts—the ventilating shafts being not available for use as construction shafts because of the necessity of building their interior framing to support the ventilating buildings while tunneling was in progress. Also, the Manhattan ventilating shaft had to be moved back from the originally contemplated location because this was found by detail borings to be located over a decomposed fault of the rock; the resulting shift of the construction shaft restricted the surface plant layout, but no interference or delay to the tunneling resulted.

Tunnel driving in the compressed air section was carried on as sketched in Fig. 5, which shows the type of shield, the arrangement for machine mucking, iron erection just after completion of a shield shove, the gravel shooting and grouting platforms, and the service hoists. When heading pressure exceeded 18 lb., the air section was divided into two stages by an intermediate bulkhead. The working system sketched was followed throughout except in full rock face. In part of the earth sections a conveyor capable of loading a train of four or five cars was used, as the mucking machine could load only one car and had to stand idle until this was backed into a siding and a new empty brought forward, but generally the character of the ground held face work down to a speed at which the

Fig. 4. Back of the shield after mucking. The next step is erection of another ring of the cast-iron lining.

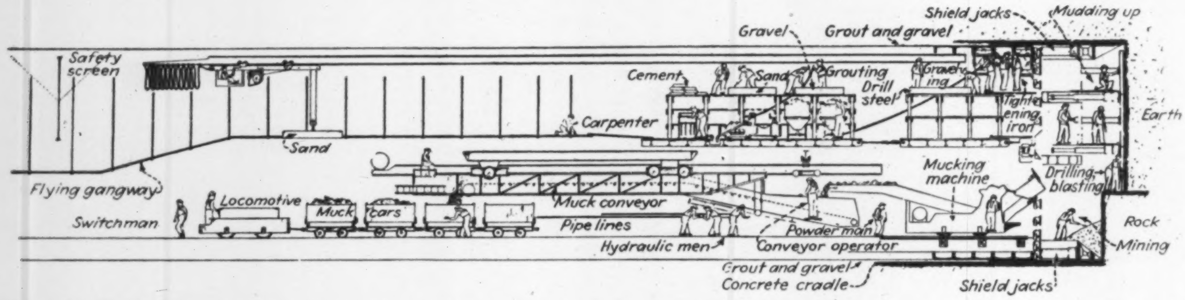


Fig. 5. Shield arrangement and mucking system as designed by the Walsh Construction Co., contractor, was used in air pressures up to 37½ lb. in driving the river tunnels. Shovel-and-conveyor mucking facilitated progress of the face excavation. Gravel shooting, final bolt-tightening and grouting followed close behind the shield.

mucker was easily able to keep up.

Skill and resourcefulness at the heading face was the biggest single factor in the success of the shield work. Illustrating the conditions that had to be met, the face at one of the worst points was as follows: upper 8 ft., lumps of coal of egg size and up; next below, 9 ft. of sand, clay, gravel and boulders; 6 ft. of decomposed rock, and finally 8 ft. of sound rock. At another point, also near the Manhattan side, the upper 10 ft. of face consisted of large stones, smaller riprap and débris, the next 2 ft. of silt, the next 10 ft. of sand, gravel and boulders, and the lower 9 ft. of rock, half decomposed and half sound. Under such conditions air blew out through the face at high rate, and the clay blanket on the river bottom was eroded and broken up, threatening collapse of the face at any moment and necessitating utmost care in supporting and sealing the face.

In all cases, as the face was breasted with horizontal lagging strips, working downward from the crown, all voids were packed with clay, salt hay or bagging. Clay was used freely in porous face to seal the ground against escape of air. Frequently the face was consolidated by grouting with a mixture of high-plasticity bentonite and sawdust and in specially dangerous ground with mixtures of hydraulic lime, cement and bentonite. Where boulders or riprap had to be removed from the face great care was used in packing back of them with clay and bagging while loosening them from the ground, to forestall a cave and blow. At all times the lagging was wedged tight against vertical wales or soldiers held by the hydraulic jacks built into the vertical partitions of the shield, or by the jack tables.

Where rock occurred in the lower section of the face, the rock bench was kept one ring back of the breasting, and blasting was kept light enough to prevent disturbance or displacement of the face support. In both part rock and full rock, a concrete cradle was laid ahead of the shield as a support for its travel. In full rock face a bottom drift was carried ahead, with constant advance drilling to explore the thickness and condition of roof and of the material ahead of the face of the drift. Where the roof over the crown of the tunnel was thin, enlargement was kept well below the crown line until the shield advanced for protection.

The average shift makeup in different kinds of ground is listed below:

TYPICAL GANGS, RIVER SECTIONS OF QUEENS MIDTOWN TUNNEL

Surface Gang (8-hr. shift, both tunnels)—surface walking boss, surface foreman, 5 laborers (handling materials) 2 cagemen, motorman, switchman, 4 men in dump hopper, 2 general utility men, 2 engineers, 2 oilers; total 21.

Heading Gang, Full Rock Face (per shift per tunnel)—heading foreman, iron foreman, 4 iron men, 8 drillers, 8 drillers' helpers, 4 muckers, shield driver, Conway mucker operator, cable man, grout foreman, 4 grout men, 2 gravel men, blaster, blaster's helper, monorail operator, hydraulic man, electrician, 2 lock tenders, 2 lock tenders' helpers, 2 brakemen, 2 motormen; total 49.

Shaft Bottom Gang (6-hr. shift, per tunnel)—Lock tender, lock tender's helper, motorman, motorman's helper, cage man, checker, mucker; total 7.

Between Locks (6-hr. shift per tunnel)—Foreman, 3 lock tenders, 2 lock tenders' helpers, 2 motormen, 2 motormen's helpers; total 10.

General for Each Shift (8-hr. shift, both tunnels)—Superintendent, walking boss, carpenter, carpenter's helper, electrician foreman, hydraulic foreman, hydraulic man; total 7.

Heading gang changed for different kinds of ground as follows:

In mixed face, 8 drillers to 6 miners, 8 drillers' helpers changed to 6 miners' helpers, and 4 muckers changed to 6 muckers.

In full face soft ground, 4 iron men changed to 6 iron men, 8 drillers changed to 8 miners, 8 drillers' helpers changed to 8 miners' helpers, and 4 muckers changed to 8 muckers.

When going normally, the heading advance per week averaged 25 ft. in rock, 48 ft. in soft ground and 15 to 18 ft. in mixed ground—on a 24-hr. day and a 6-day week. Interruptions, stoppages to build bulkheads and other factors made the over-all average lower, of course; over a two-year period from the time tunneling work began the progress averaged 14.5 ft. per week in the most difficult heading and 21.4 in the least difficult.

Highest rates in rock were attained where most of the excavation had previously been taken out by bottom drift; during the week ending Dec. 17, 1938, 121.7 ft. advance was made in one heading. Highest advance in soft ground was made during September, 1938, when weekly figures of 56 ft. were reported by each of the Queens headings; in mixed ground during June, 1939, when during five weeks a continuous record of 27 ft. per week was made in one Queens heading and 26.1 in the other.

In spite of rapid progress, high air pressures and difficult and variable ground, an exceptional safety record was made, largely by virtue of special care in medical examination and supervision. Not a single fatality occurred from bends. All cases of bends were restored by hospital-lock or other treatment.

Placing the lining

Where possible, the iron was erected high and to a vertical diameter greater than the horizontal. Beginning immediately after a shove the tail of the shield was cleaned out ready for a new ring, packing was placed around the last ring to exclude dirt and water and decrease the escape

CONTRACTS—QUEENS MIDTOWN TUNNEL

Description	Contractor	Work Started	Est. Cost	Remarks
Borings	Sprague & Henwood, Inc.	10-2-36	$3,644	Completed
Borings	Sprague & Henwood, Inc.	10-19-36	49,585	Completed
Borings	Standard Drilling Co.	10-6-37	4,477	Completed
Queens Construction Shaft	G. A. M. Construction Corp.	9-22-36	201,074	Completed
Manhattan Ventilation Shaft	Triest Construction Company, Inc.	1-4-37	299,332	Completed
River Tunnels and Shafts	Walsh Construction Co.	7-14-37	22,112,000	
Dredging and Pile Driving	Merritt-Chapman Scott Corp.	9-14-38	62,908	Completed
Manufacture, Storage and Delivery of Cast-Iron Tunnel Lining	United States Pipe & Foundry Co.	1-4-37	3,356,001	
Manufacture, Storage and Delivery of Bolts, Nuts and Washers	Bethlehem Steel Co.	3-8-37	195,006	
Queens Land Section	Charles F. Vachris, Inc.	4-25-38	2,263,100	
Manhattan Land Section	Woodcrest Constr. Co., Inc., & Rosoff Bros., Inc.	6-8-38	3,454,308	
Manhattan Ventilation Building	Cauldwell-Wingate Company	7-18-38	658,000	
Queens Ventilation Building	Cauldwell-Wingate Company	11-29-38	547,400	
Fans and Motors	B. F. Sturtevant Co.	12-22-37	284,689	
Manhattan Plazas	Geo. J. Atwell Foundation Corp.	7-24-39	1,918,400	
Demolition, Manhattan	M. Klotz, Inc.	3-7-39	43,495	Completed
Mf., Stg. and Del. Ceiling Tile	Bridgeport Hardware Mfg. Corp.	10-5-38	238,500	
Queens Plaza	Thos. Crimmins Contracting Co.	5-16-39	622,100	
Demolition, Queens	Knickerbocker Demolition Corp.	1-24-39	16,625	Completed
Electrical Wiring	L. I. Waldman & Co., Inc.	6-15-39	548,413	
Electrical Control Boards	General Electric Co.	9-22-39	427,750	
Tunnel Finish	Atlas Tile & Marble Works, Inc.	12-5-39	336,733	
Service Bldg. & Emergency Garage	Cauldwell-Wingate Company	5-24-39	298,860	
			$37,942,400	

Contracts not let (*Estimated cost $2,000,000*) — Manhattan surface approaches, electric lighting fixtures, pumps, toll booths, plaza finish, Queens, plaza finish, Manhattan, paving, operating equipment.

Note: 75 per cent of contract work has been completed.

of compressed air, and the flange faces were wiped clean ready for a new ring. The lowest segment was set in place, at zero clearance if possible, and the bolts placed and at once tightened by hand wrenches to 25,000 lb. per sq. in. Erection of additional segments followed, bolts in both longitudinal and circumferential joints being placed and tightened. Minor adjustment of position and shape of ring was possible because of the $\frac{1}{8}$-in. clearance of the bolts in their drilled holes. When the lining reached the track floor all bolts below the platform level in the two previously erected rings were pulled up a second time before extending the track forward for mucking. The remaining segments were placed and bolted loosely and keyed up, the horizontal center tie-rod placed and pulled up, and all bolts tightened. Finally, before the next shove, the bolts above the platform level in the two rings last erected were again tightened.

Gravel blowing was done in all segments of the ring directly back of the shield tail during each shove. The gravel pan was mounted on a platform dragged back of the shield on track rails bolted to the sides of the lining. In general, the amount of gravel consumed about equalled the computed void left behind the shield tail. Grouting with a 1:1 mix of sand and cement or neat cement grout followed 10 to 15 rings behind, from the same platform, under a tank pressure of 100 lb. per sq. in. Grout consumption varied widely, depending on density of gravel packing and distance of flow.

Within the distance of 25 to 30 rings back of the shield the lining usually deformed somewhat, the horizontal diameter increasing $\frac{1}{2}$ to 1 in.; as no change in shape was observed farther back, it may be concluded that the ground gives full support to the lining. The temporary horizontal tie-rods were left in place only for 50 to 75 ft. back of the shield. At points of special stress, as at the sump and Manhattan River bulkhead, permanent tierods were placed at upper and lower quarter points, to be embedded in ceiling and floor concrete.

Calking the lining joints (with lead wire) and pointing with cement will be done after completion of the tunnel structure and immediately before placing the concrete lining.

Tunnel twice flooded

Critical difficulty was encountered on two occasions, both of them during the driving of the Manhattan headings in the bad ground near the river bank, where boulders, riprap, coal and miscellaneous dump materials were encountered. In the first case the north heading was drowned out in extinguishing a fire at the heading and the tunnel was lost for seven weeks. In the second the south heading advanced through material so open and unstable that a blow and partial run dropped the pressure and the tunnel flooded to the upper quarter, but the face crew stayed on the job and regained control.

The fire in the north heading occurred on June 26, 1938, probably

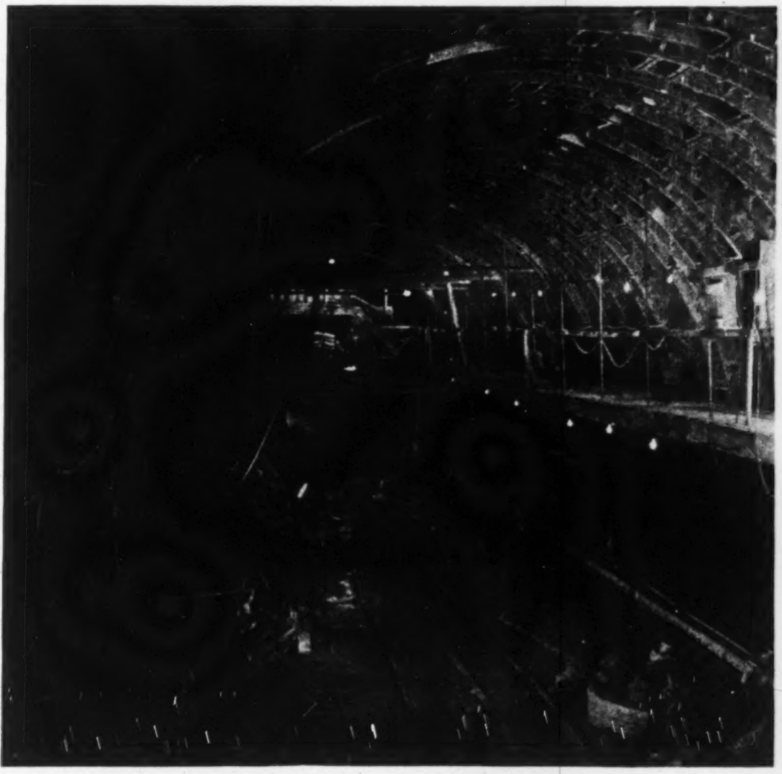


Fig. 6. Looking toward shield in North Queens Tunnel. At the right is the flying gangway shown in Fig. 5.

through accidental ignition of packing hay or other combustible material temporarily stored on the grouting platform. It was discovered when the Sunday night shift came on following the day's shutdown, and the men were unable to enter because of smoke. Partial flooding of the tunnel apparently did not control the fire, and several hours afterward the face gave way and the tunnel filled. As the two headings at this time were nearly abreast, it was decided to drive the south tunnel some 75 ft. or more before attempting to unwater the north tunnel. This was done during the seven weeks following the flooding.

Recovery was accomplished on Aug. 9 (see *ENR*, Aug. 25, 1938, p. 229); after the ground ahead of the face was grouted through pipes driven down from the surface and across from the shield face of the south heading. Combined pumping and raising the air pressure lowered the water sufficiently so that men were able to float out on rafts to the shield from the upper or emergency air lock, pack the joint at the tail of the shield, which was blowing air heavily, and bulkhead and pack the upper shield pockets. A plank bulkhead driven through the muck that had run into the lower half of the tunnel finally made it possible to clear the tunnel of water and then regain the face by cutting through the bulkheading of the upper pocket.

At the time of the fire the north and south headings were nearly abreast, both of them in ground of the worst kind. Work in the south heading was at once stopped and the face was grouted with a mixture of sawdust and bentonite to reduce air loss and the chance of a blow. Progress was resumed two days later, with constant grouting, to get the face well ahead of the north heading. Three weeks later, however, the face breasting gave way in part, a small run occurred, the air pressure dropped, and air consumption rose to 46,500 cu. ft. per min. Water filled the tunnel to within 9 ft. of the crown.

Under these extreme conditions the heading force stayed on the job and managed to control the blow. The shield was shoved blind (without face excavation) an entire ring length, which action, by consolidating the face material, allowed the pressure to be raised and the tunnel cleared. A ring of lining was erected, and again the shield was shoved blind. Then grout was injected into the face and through the lining grout-holes near the shield tail, and conditions were so stabilized that normal progress became possible.

The tunnel is being built by the New York City Tunnel Authority, for which Ole Singstad is chief engineer. Construction of the river tunnels by the Walsh Construction Co. was directed by John S. Macdonald, vice president and chief engineer. Harry Redwood is chief superintendent.

The cast-iron lining for the river tunnels, 55,300 tons, was cast and machined under a contract awarded to the United States Pipe & Foundry Co. Its production was sublet to Bethlehem Steel Co., Bethlehem, Pa., Continental Roll & Steel Foundry Co., Wheeling, W. Va., and Davies & Thomas Co., Catasauqua, Pa. The steel lining was produced by the Bethlehem Steel Co. Other important contracts are given on p. 57.

Chemical Control of Water Weeds

CONTROL OF ALGAE and rooted weeds in Wisconsin streams and lakes has been studied for two years by a special committee headed by L. F. Warrick, state sanitary engineer, and a report issued in July, 1939, reviews the relation of such growths to both public welfare and fish life. Research in the field and the laboratory has included also the supplementary subject of the trouble known as "swimmers' itch", a skin irritation caused by certain larval parasites of water snails.

Chemical treatment for control in Wisconsin waters began some years ago under Dr. Bernhard P. Domagalla, city bio-chemist of Madison, Wis. (*ENR*, Dec. 9, 1926, p. 950). In 1938, residents in the vicinity of Lake Pewaukee sought to have such treatment applied, but there was opposition on the ground that it would be detrimental to fish life. This controversy led to an intensive study of the problem in order to develop a uniform policy and procedure by the state authorities. Copper sulphate as used for the control of algae is applied when the growth begins, several applications being made.

The character of the local water is an important factor in each case. From experiments in the field and in the hydraulic laboratory of the University of Wisconsin it appears that copper sulphate should be applied as a solution of less than 0.5 per cent. The toxic dose for fish was found to be 200 ppm in the hard water of Lake Mendota (alkalinity content 150 ppm), and the safe dosage was set at 150 ppm. But a statement found in literature gives the toxic dose as only 2.1 ppm. From careful investigation it is believed that the published statement is based on experiments in distilled or very soft water, in which algal conditions rarely occur. In hard water, the calcium carbonates and bicarbonates react with the copper sulphate to produce an insoluble copper compound which is not injurious to fish. Furthermore, the majority of the copper is generally thus removed from solution in half an hour. For these reasons, a heavier amount of the chemical may be used without affecting fish life.

Sodium arsenite has the same effects in both hard and soft waters, but has no toxic effect upon fish life until the strength approaches 10 ppm. To control aquatic rooted weeds at bathing beaches and in boat channels, the dosage gives an arsenic trioxide content equivalent to 1 ppm, which is thus perfectly safe for fish life.

For the control of the "itch" larvae by removal of the snails in which they develop as parasites, copper sulphate has been used, but the required strength is likely to be injurious to fish life. Copper carbonate is recommended in the report as being safer and simpler. It is scattered dry. The volume of water (in cubic feet) overlying the area to be treated is multiplied by 0.0003 to give the amount of carbonate (in pounds) for saturation. Four times this amount is recommended for application, in order to insure a constant supply of the toxic copper ions over a period of a few days.

Lake Erie Water For Toledo

***Contents in Brief**—Abandonment of the polluted Maumee River for Lake Erie as a source of water has led to the construction of new supply and treatment facilities at Toledo, Ohio. These include a 2-mile pipeline, pumping stations, filter plant additions and distribution improvements.*

EIGHT MAJOR ELEMENTS make up the new water supply facilities for Toledo, Ohio, where Lake Erie water will soon replace the polluted Maumee River source. These elements are: an intake 2 miles from shore, an intake conduit, a lake shore raw-water pumping station, a 78-in. pipeline 2 miles long to a filter plant on the edge of the city, an 80-mgd filter plant, a filtered water reservoir, a high-lift pumping station and a trunk main across the city. The following extract from a paper by Paul Hansen, consulting engineer, presented at the Ohio Conference on Water, summarizes novel features of the project.

The intake had to be placed in comparatively shallow water (20 ft. deep) and provisions were made to offset troubles from frazil ice and pressure ice conditions. Accordingly, the intake was built to extend above water, and quarters are included to house men who will be on duty to combat ice formation. The intake ports are large and low, and velocities of flow not to exceed 0.25 fps are planned to reduce frazil ice difficulties. Ports are flared into a large cross-section through the exterior walls to facilitate dislodging ice from the interior through the use of dynamite. The lower portion of the structure will be armored with steel plates as further protection (Fig. 3.).

The 108-in. intake conduit is 15,490 ft. long and comprises a land tunnel and reinforced concrete pipe in trench for the lake section.

At the raw-water pumping station, four low-lift pumps are arranged in two pits, so that only two pumps in one of the pits will be out of service in case of a major pipe break. Intake and discharge conduits are long and create a wide variation in head discharge conditions. Studies showed that for efficient pumping, the equipment might be either a relatively large number of single-speed pumps, a smaller number of 2-speed pumps or a minimum number of variable-speed units. Analysis of the costs showed that four variable-speed units, one of 55 mgd at 60-ft. head and three of 50 mgd at 110-ft head, would be the most economical considering operating and total annual costs. To suppress surges, should electric power be cut off suddenly, automatic cone valves with controlled and adjustable timing of operation are provided. Also, surge suppressors will admit air to the pipeline during the down surge and discharge water to the inlet chamber during the returning of surge.

For the filter plant, the following are the bases of designs. The reaction period will be 45 min.; sedimentation, 3 hr.; normal filtration rate, 2 gal. per sq. ft. per min. Four reaction chambers integral with the four sedimentation tanks are to be equipped with paddle-wheel flocculators. Parallel operation only of reaction chamber

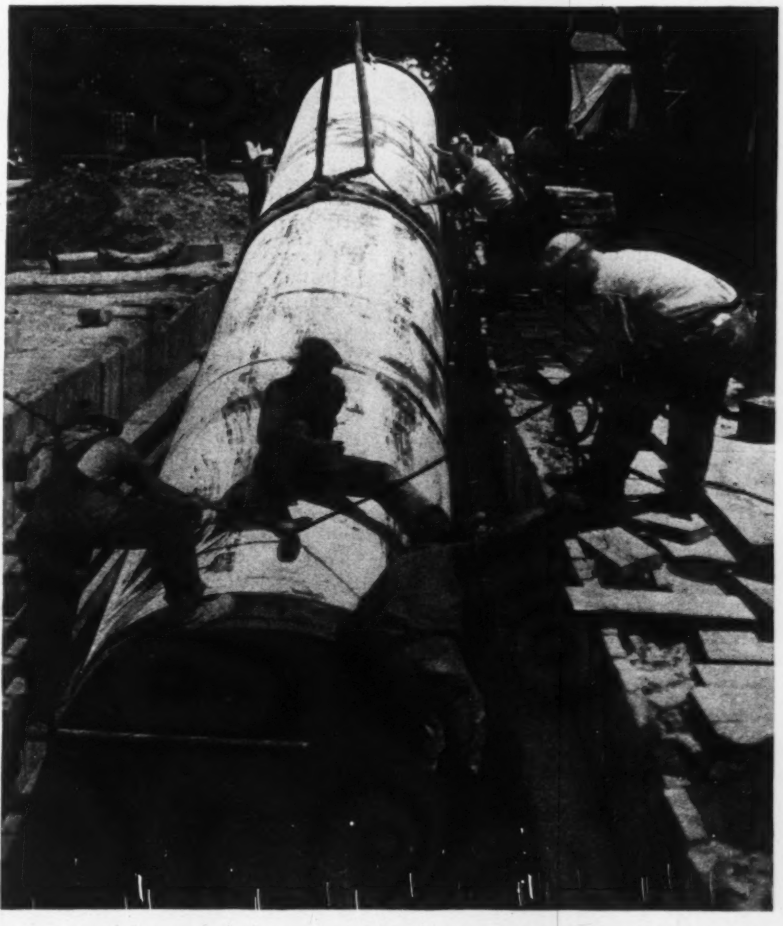


Fig. 1. **A 72-in. steel pipe, part of the new distribution main at Toledo, being "nosed" into a trench. A wire screen over the open end of the pipe keeps out debris. The sling cables are incased in rubber hose to prevent injury to the pipe coating**

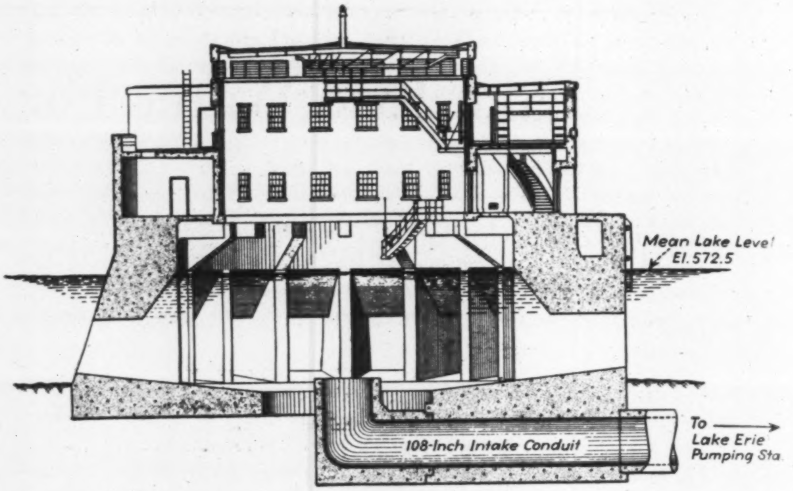


Fig. 3. Intake crib located 2 miles offshore in a 20-ft. depth of water. The intake ports are shaped to facilitate removal of ice formation.

and sedimentation basins was considered essential. Each of the twenty filter units is divided into two beds, each bed separately controlled as to effluent and washwater. Backwash up to 25 gal. per sq. ft. per min. and a surface wash of 10 gal. per sq. ft. per min. are provided. The latter is through perforated caps on the ends of vertical pipes spaced on 2-ft. 9-in. centers. Each cap has a central hole directing the jet downward and four other holes directing jets at an angle of 38 deg. with the horizontal. Holes are ⅜-in. in diameter, producing a maximum jet velocity of 45 fps. Wheeler filter bottoms are used.

Because of subsoil conditions the 35-mg clear well is 500 ft. away from the filters and has a small 2-mg chamber feeding a large 33-mg chamber over a weir. The high-lift pumps ordinarily take water from the small unit. Should the small chamber be drawn down a flap gate will automatically admit water from the larger chamber.

No ideal site for the filter plant was available as all areas where the plant might be built were underlaid by thick layers of plastic clay. Loads therefore had to be limited, and numerous tests on core borings were made to determine the best location. This led to the conclusion that it would be inadvisable to construct any new structure adjoining an existing one which might set in motion the plastic material underneath. In consequence, the clear water reservoir was not placed under the filters, as in normal practice, and no provision is made for future additions to be located adjacent to existing structures. The chemical and administration buildings rest on caissons carried to rock 60 ft. below the surface. For economy, a 1,500,000-gal. tank is to be built integral with the building. This tank is for washwater storage and will also feed through automatic valves into the distribution system should the pressure suddenly drop due to electric outage.

Notable in the high-lift station is the provision for three independent sources of electric power, two underground. The security is considered sufficient so that no standby equipment is provided as at the low-lift station where two 600-kw generators are driven by internal combustion engines.

In the trunk main is a river crossing in rock tunnel 110 ft. below the surface. Bids on the work showed the rock tunnel to be cheaper than one in earth at a depth of 60 ft.

The work is being carried out under the direction of George N. Schoonmaker, city manager, and Robert W. Furman, commissioner of water. William G. Clark, veteran consulting engineer long associated with the Toledo plant, is in general charge of construction. L. G. Williams is the resident engineer representative of Greeley & Hansen, consulting engineers, Chicago, who are preparing plans and will maintain general advisory supervision of construction. About one-half the work was under contract in November.

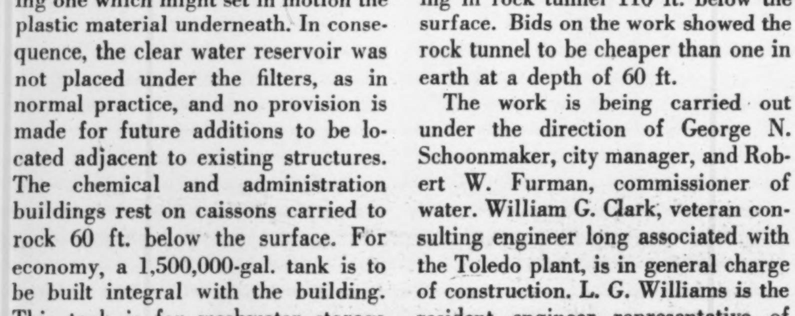


Fig. 2. Water for Toledo will come from Lake Erie following abandonment of the Maumee River supply.

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Italy Reclaims Marsh Lands

Land reclamation and agricultural development are being carried out in Italy on a large scale, both by the government and by private enterprise with government aid. In October there was celebrated the completion of the last of the new towns established on the fertile farm lands converted from the former fever-breeding Pontine marshes, near Rome. Similar work is being carried on in other districts. Reclamation and the construction of new settlements in Sicily includes, as the first step, an area of 1,250,000 acres, on which 20,000 farm houses are to be built, and an organization has been set up to assist landowners in improving and reconditioning their own lands and estates. In Sardinia the reclamation of 40,000 acres, with 4,000 farms was completed recently. After each area has been drained, roads are built and the land is prepared and divided in accordance with definite plans. In addition to the extensive work of this kind, government aid has been granted for hydro-electric developments in Sicily, owing to special difficulties involved in these projects.

Precast Concrete Slabs Face Bridge Abutments

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***Contents in Brief**—Grade separation bridges on Connecticut's Merritt Parkway have been given a great variety of architectural treatments. The latest and one of the most interesting involves the use of thin factory-made exposed-aggregate slabs of unusually strong and dense concrete for abutment facing. Similar concrete with colored aggregates is used for ornamental plaques.*

CONSTRUCTION of the Merritt Parkway has provided engineers of the Connecticut highway department with many problems of unusual interest. Particularly, the seventy-odd highway grade separation structures offered an unusual opportunity for the exercise of originality and the development of methods and materials not usually employed in bridge construction. As stated in a previous article (*ENR*, Sept. 23, 1937), it was decided when starting the project to make but sparing use of masonry facing and, instead, to attempt the task of providing a series of bridges, essentially in steel and concrete, which would be judged worthy of their parkway setting. At the same time it was determined to avoid any semblance of standardization and to resist at all times the natural tendency to repeat in one location what was considered a particularly satisfactory design in some other location. Thus the several bridges produced are each sufficiently different in form and detail to avoid an appearance of monotony and, it is hoped, to give added interest to a trip over the parkway.

The application of these principles soon led to a consideration of new, or at least unusual, methods and materials. It was during the process of inspecting such materials, in course of manufacture at a local plant, that the attention of the department's engineers was called to what was, to us, a new type of cast stone unit. Briefly, this consisted of large concrete slabs, some 10 to 12 ft. square and 2 in. thick, designed for use as an external facing for the model-testing building being built for the Navy Department at Carderock, Md. The excellence of the lines and surface finish being obtained led to speculation as to the suitability of the material to bridge construction and to the eventual decision to employ it as a facing for the abutments of the bridge, now nearing completion, which will carry Clinton Ave. over the Merritt Parkway in the town of Westport.

Manufacture of slabs

Although these slabs may be manufactured in sizes up to 10 or 12 ft. square, the actual size of the units, of course, is adapted to the requirements of the design and construction. They are customarily made with returns and mouldings cast integral with each section of slab so that joints do not come at corners or at details of ornamentation. This makes for sharp clear outlines at all points. The slabs are uniformly 2 in.

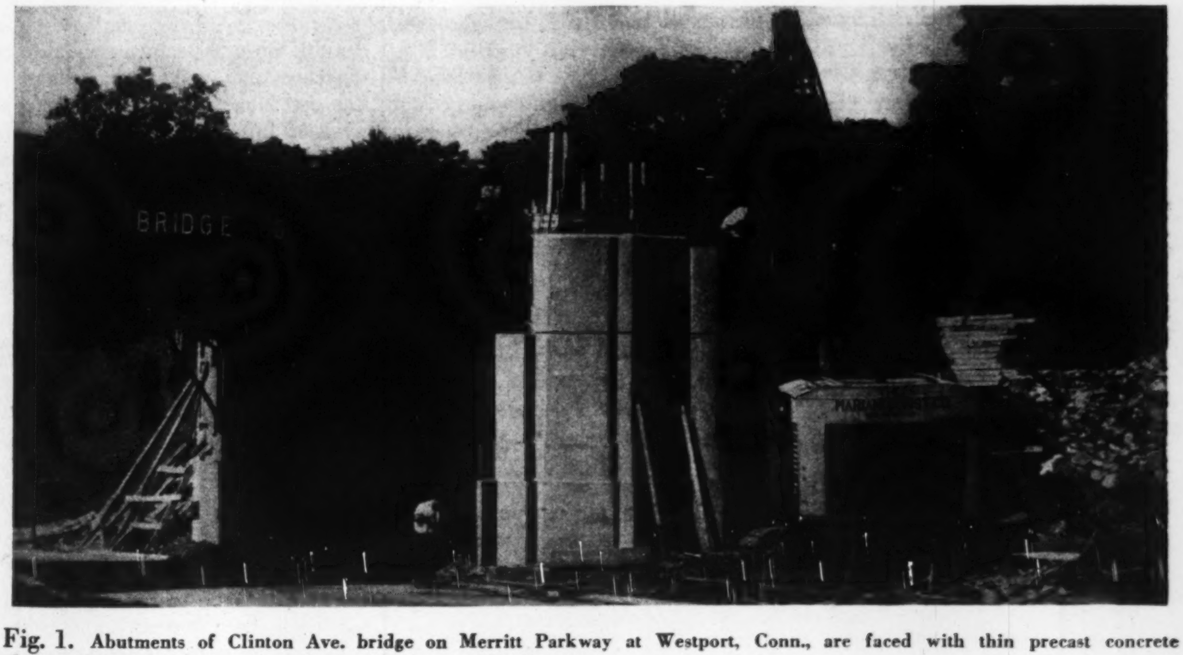


Fig. 1. Abutments of Clinton Ave. bridge on Merritt Parkway at Westport, Conn., are faced with thin precast concrete slabs which also serve as front forms during construction.

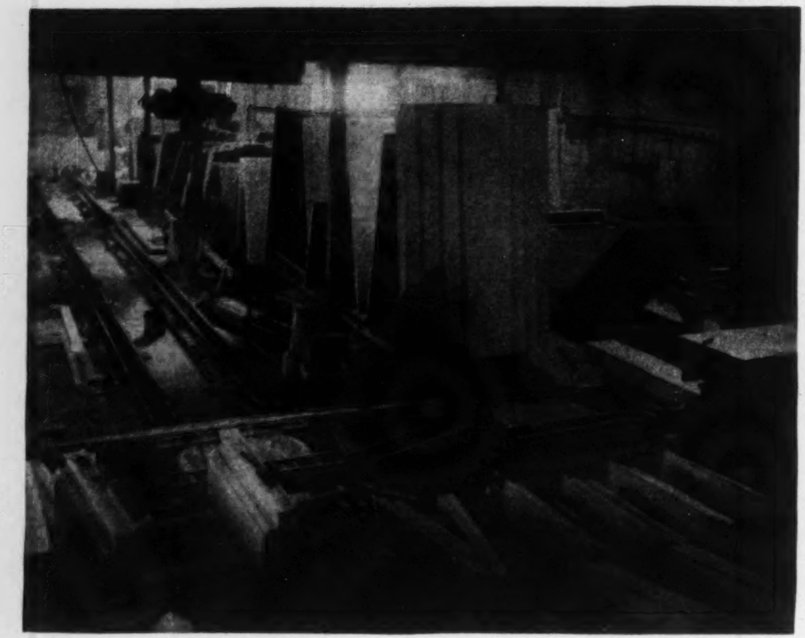


Fig. 2. **Shop manufacture of architectural concrete slabs. Within 12 hr. after pouring, slabs are raised upright onto easels as shown, where curing progresses and where surface brushing and finishing is carried on.**

thick, and are reinforced with ¼-in. galvanized steel wire mesh having about 3-in.-square openings. U-shaped steel anchor plates are attached to the reinforcing at about 2-ft. centers in each direction, the middle portion of the U, projecting beyond the back of the unit, being provided with a hole for the insertion of a bolt to hold the unit in position during the placing of the backing and to assist in anchoring it to the concrete. The plates are also useful in handling and setting the slabs.

The desired surface appearance is obtained by the use of special aggregates and cements. These, however, need only be used in the outer 1 in. of thickness, thereby reducing the cost of the unit. Forms are carefully and substantially built, with an eye to reuse, and are lined with composition board and with metal when necessary.

The materials, proportions and methods of mixing, placing and curing are carefully controlled so that a very fine quality of concrete is produced. Vibration is used as an aid and, as the future exposed surface of the unit is at the bottom during pouring, this brings excess water, fines, laitance, etc., to the back, which is the least important surface of the slab.

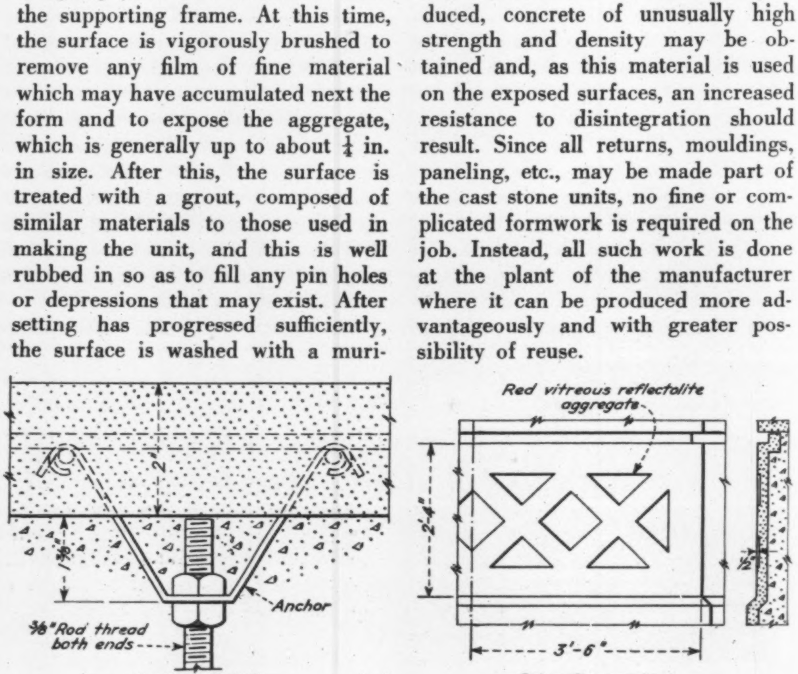
As soon as possible after pouring, usually within 12 hr., the units are removed from the forms and placed on "easels" so that the finished surface is exposed. During the remainder of the curing period they remain in this position. Frequent tests are made with straightedges, and any tendency to warp is corrected by means of wedges placed between the unit and the supporting frame. At this time, the surface is vigorously brushed to remove any film of fine material which may have accumulated next the form and to expose the aggregate, which is generally up to about ¼ in. in size. After this, the surface is treated with a grout, composed of similar materials to those used in making the unit, and this is well rubbed in so as to fill any pin holes or depressions that may exist. After setting has progressed sufficiently, the surface is washed with a muriatic acid solution to etch it, remove excess grout and expose the aggregate, which gives the surface the desired appearance. This completes the process of manufacture, and after curing until sufficient strength has been attained the units are ready to ship to the site of the work.

Installing the slabs

The slabs are set in position on beds of mortar, and lead "pellets" if necessary, to insure their remaining at correct elevations. Form tiebolts are inserted and attached to the rear forms in the customary manner, so that the unit becomes for all practical purposes the front face of the form. In practice, it has been found advisable to add bracing to the front face to prevent the cast stone slabs from being moved out of plumb during the placing of the concrete backing. This backing is placed in the usual manner and, upon completion, the joints between the slabs are pointed and finished as for ashlar masonry.

Advantages of slabs

While the use of this material is regarded to some extent as experimental, there are certain obvious advantages which may be counted on. Because of the improved conditions under which the units are produced, concrete of unusually high strength and density may be obtained and, as this material is used on the exposed surfaces, an increased resistance to disintegration should result. Since all returns, mouldings, paneling, etc., may be made part of the cast stone units, no fine or complicated formwork is required on the job. Instead, all such work is done at the plant of the manufacturer where it can be produced more advantageously and with greater possibility of reuse.



Anchor Detail

Pylon Ornament

Fig. 3. **Details of architectural concrete slabs showing method of anchoring and an ornamental plaque.**

By the use of these units, it is possible to determine in advance the appearance, color and texture of finished, exposed surfaces. This is a distinct advantage over the customary type of poured construction. Again, since the units are so thin, it is possible to employ special cements and aggregates and to use more than one color for panels, inset designs, etc. For the Clinton Ave. abutments, certain panels are slightly depressed and are made with red vitreous aggregate of high refractive quality. Thus it is possible to add a note of color to the design.

From the construction standpoint, the units are advantageous in that they eliminate troublesome details caused by the need to locate construction joints where their presence would spoil the appearance of the bridge. Since the entire exposed surface is covered by the cast stone slabs, these joints may be made at any desired point. Surface finish—that is, rubbing with carborundum bricks to remove form marks and finish off the surface—is, of course, entirely eliminated. This is not only an economy but may have an additional advantage in preventing one form of disintegration, the "craze" cracking, discoloring, etc., which many consider to be due, in part at least, to the results of this operation.

These are some of the advantages that may be fairly expected to result from the use of this type of construction. Whether they will all materialize, or whether their attainment will be accompanied by at present unforeseen disadvantages, can only be determined by the test of time.

The manufacturer is required . . .

The specifications under which this material is purchased cover several pages but the essential requirements are contained in the following short paragraph:

> The acceptance of any cast stone units shall be based on the results of physical tests and on visual inspection to determine their conformity with the requirements of the plans and specifications as to dimensions, details, colors and surface finish.

The required physical properties include a minimum compressive strength of 7,500 lb. per square in. at 28 days and an absorption of not more than 7 per cent by weight. Certain restrictions relative to the qualifications, equipment and experience of the manufacturer are also included, but the gist of the requirements is that, having selected a qualified manufacturer and having advised him as to the dimensions and finish required, it is better to leave the details of manufacture to his judgment and experience.

Costs

One further point of interest is that of cost. The Clinton Ave. bridge, the only structure on which these facing slabs have been used to date, is a single-span 88-ft. steel rigid frame which carries a 30-ft. roadway over the parkway at a skew angle of 32 deg. It was placed under contract in April, 1939, at a cost of $63,000.

The cast stone items consist of 6,770 sq. ft. of concrete slab facing 2 in. thick, and 300 cu. ft. of cast stone copings for the top finish of walls and railings. The contract prices for these two items are $1.30 and $3.00 respectively so that the total cost is $9,700 for the structure.

These costs will compare favorably with the cost of masonry facing of the customary type although the effects produced are so entirely different that the two types of construction can hardly be said to be comparable. While one structure, and that not yet completed, hardly offers an adequate basis for prediction, it is felt that these thin, factory-made concrete slabs offer interesting possibilities for a new technique in concrete construction and are perhaps capable of a wider application in the solution of bridge problems.

The Clinton Ave. bridge was designed and its construction is being supervised by the engineers of the Connecticut highway department. The general contractor for the structure is the Mariani Construction Co., New Haven, while the cast stone units are being furnished by the Dextone Co., New Haven.

Bentonite Stops Sewer Leakage

EMERSON C. HALLOCK

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Westchester County, White Plains, N. Y.

LEAKING JOINTS in a sewer have been successfully sealed with a mixture of quick-dispersing bentonite clay and water, which was forced down into holes over and near the sewer pipe. The work was done under the direction of the writer on an 8-in. clay tile sewer in Boyerstown, Pa. The sewer was 10 ft. deep and the cost of sealing the joints was about 5c. per foot of pipe.

Bentonite is a clay which swells many times its dry size when it is wetted. When it dries, it clings to the surrounding earth but upon rewetting it again swells. The material does not harden but it becomes impregnable as far as water passage is concerned after it becomes wet. Introduced on the outside of a pipe by means of a diluted mixture, the swelling of the material causes it to fill the voids or porous areas around the pipe.

The manner of applying the bentonite mixture is as follows: first a hole is made over or near the sewer pipe by working a long bar with pointed ends down to the approximate depth of the sewer. Then a pipe is inserted in this hole through which the diluted mixture is applied. If a void should be in the vicinity of the hole, the mixture will flow by itself. However, in most cases, it is desirable to force the mixture into place using a small centrifugal pump for this purpose. A 4 per cent mixture of clay and water has been found generally satisfactory.

It is not necessary to make a hole over every joint in the pipe line because in many cases the voids are interconnected. For the first trial, at least, every fourth joint will suffice.

Experiments are under way in the application of a bentonite mixture packed around sleeve type joints. Joints have been made up which stood a 6-ft. head of water for six weeks without a drop of moisture showing on the joint. At the end of the test the pipe was lifted by a crane without causing any leakage.

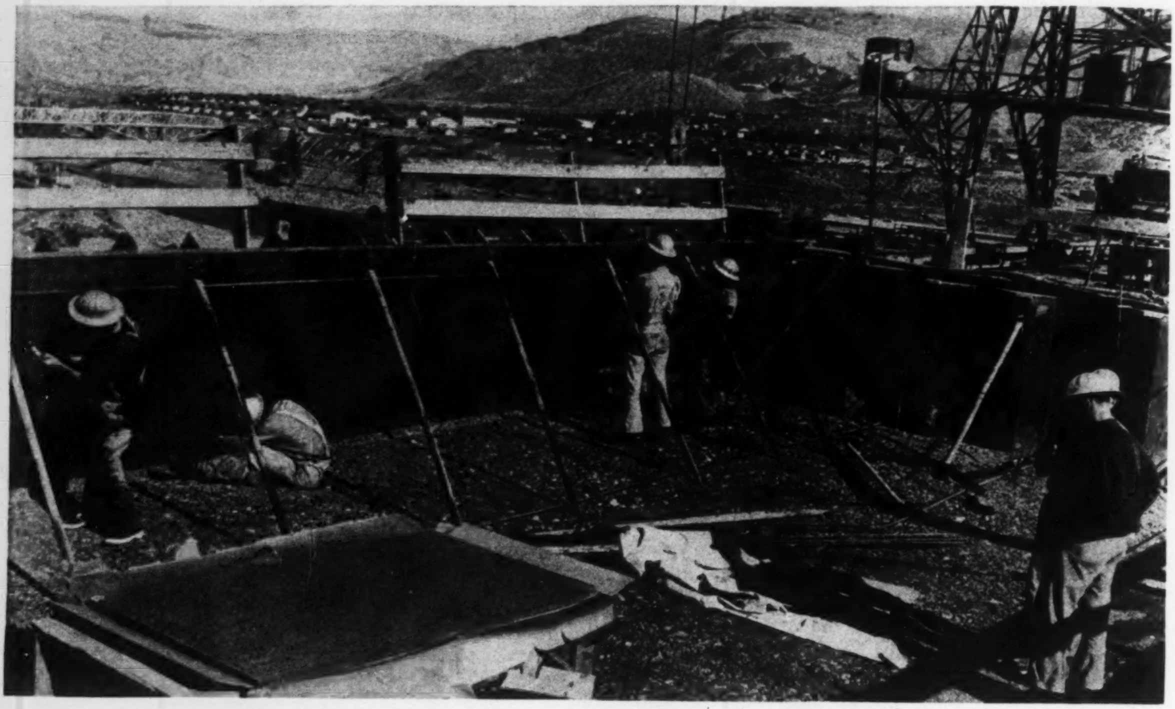


FIG. I. INSTALLING ABSORPTIVE FORM LINING ON REGULAR FORMS IN FIELD TESTS AT GRAND COULEE DAM.

Concrete Surfaces Improved By Absorptive Form Lining

***Contents in Brief**—Search for an absorptive lining for concrete forms for spillways of high dams has resulted in the Bureau of Reclamation making elaborate tests of building boards. The problem is to find a board which is effective in absorbing excess water and air but which will not bond to the concrete.*

NEED FOR IMPROVING the surface quality of concrete to reduce the effect of erosion has become so important in connection with high dam spillways that the Bureau of Reclamation has inaugurated an extensive investigation to find form lining material that will absorb air bubbles and excess water. With these two causes of rough and pitted surfaces removed it is believed that the water at 152-fps velocity, which will flow over Shasta Dam will have its erosive effect materially reduced especially on the surface of the spillway bucket. Elimination of air voids on the concrete surface will reduce cavitation. Reduction of the water-cement ratio by absorption of water, which accumulates in a thin layer against the surface of the overhanging form, should produce a superior quality of concrete capable of great resistance to abrasion. Tests in the Denver laboratory on forms with an upper facial slope of 0.8 to 1.0, the designed slope of the Shasta overflow section, indicate excellent results are possible with special types of insulating wall board.

Laboratory tests

In the early part of the work many surfaces appearing relatively smooth and free from pits were found underlaid by numerous voids with only a thin mortar film covering them. In consequence all specimens were stoned or wire brushed to uncover these defects. Such a stoned surface cast under a sloping form is noted in Fig. 2. Bubble incidence and formation were studied under forms made of glass plate, air being withdrawn with a pipette, and under pyralin, air being released through pinhole perforations. Suction applied uniformly to a special form removed the air as it collected and produced a relatively smooth voidless surface. In a simpler method of air removal a piece of heavy muslin was stretched over an ordinary fly screen which was backed by wood forms.

Air removal as accomplished by the latter method was considered too cumbersome and expensive for field use. Further investigations included porous and absorptive insulating building boards. Boards tried for aspiratory capacity included those fabricated from wood, straw and cane fibers having surfaces commonly described as plain-pressed, lithoponecoated, hot-rolled and plain-sanded. Concrete stuck to all these surfaces causing difficulty when the forms were stripped. Various types of coatings and surface treatments were tried with varying degrees of success.

Linseed oil on coarse-texture wallboard resulted in excellent concrete faces and gave no trouble in stripping. However, linseed oil inhibits set and, with the lesser absorption due to slight sealing, produced a surface inferior to the surface produced back of more absorptive untreated boards. A muslin covering was then used to prevent bonding and still not seal the board. The method was successful in producing a smooth void-free surface. See Fig. 3. The form board was easily removed and the cloth peeled from the concrete surface.

The interest and cooperation of several manufacturers of insulating board was secured, and encouraging progress has been made in developing more satisfactory boards for form lining purposes.

Many additional desirable structural qualities were found in the specimens made in forms lined with an effective absorptive material which permitted the escape of superficial air and absorption of excess water from the surface of the newly placed concrete. After 50 cycles of freezing and thawing of two 9x9x3-in. identical mix specimens, one cast in muslin-covered absorptive form lining and one in ordinary wood forms, Fig. 4, the former lost no weight and the latter 22.6 per cent by weight. (A 25 per cent loss is considered complete failure in standard practice.)

Susceptibility to crazing was determined by dashing ice cold water daily on two specimens left in the sun. After twelve applications of the water the specimen cast against wood crazed extensively while the other was unaffected.

While the engineers handling the investigations feel that suitable boards will be developed by the manufacturers without using a fabric covering, a method of rolling on cheap muslin cloth has been devised. Co-operating manufacturers are the Celotex Corp., Fir-Tex Insulating Board Co.; The Insulite Co.; Wood Conversion Co., and the Masonite Corp.

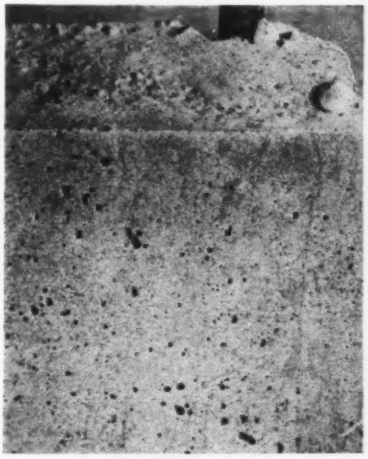


Fig. 2. Surface voids appearing in concrete cast under a sloping plywood form. The surface was rubbed with stone to disclose hidden voids. Note sand streaks due to rising of excess water.

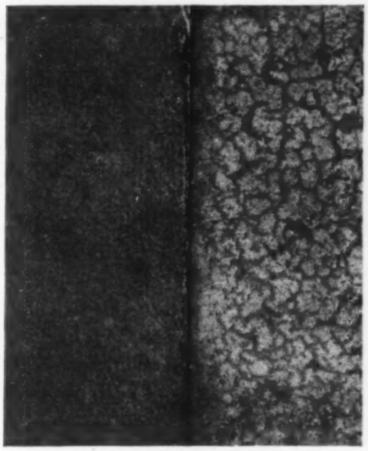


Fig. 3. Surface of a block cast in absorptive-lined form (left) showed no crazing under 12 daily applications of ice water while that cast in a wood form crazed readily.

Field tests at Grand Coulee

Large-scale field tests have been conducted at Grand Coulee Dam on the 50-ft. concrete blocks which are placed in 5-ft. lifts. The best absorptive boards developed to date for form lining by several manufacturers have been tried on a total of 22 panels. Handling, installation, form removal and salvaging problems, compacting methods and general construction technique have been studied in the light of results obtained. Observations and conclusions from the field tests may be summarized as follows:

1. Absorptive linings for forms can be developed that will materially improve formed surfaces on mass concrete work.

2. Conditions at Grand Coulee Dam, which are typical of a large mass concrete job, impose a difficult combination of factors which would not be present in ordinary work. These factors include relatively dry concrete (about 2-in. slump), large batches (4 cu. yd.), large aggregate (6-in. max.), heavy vibrators, overhanging forms (0.8 to 1 slope) and complicated construction conditions.

3. None of the boards included in the Coulee Dam trials were entirely satisfactory from the viewpoints of absorbing water from the freshly placed concrete and eliminating air pockets.

4. Some sticking of the form lining to the concrete was encountered. The stuck portions were easily removed, but the process of form lifting was complicated and any possible salvage value of the lining for resale as insulating board is questionable.

5. It is impracticable to use the absorptive form lining board more than once.

6. Cutting, fitting, drilling and installation of the form lining board presented no particularly difficult

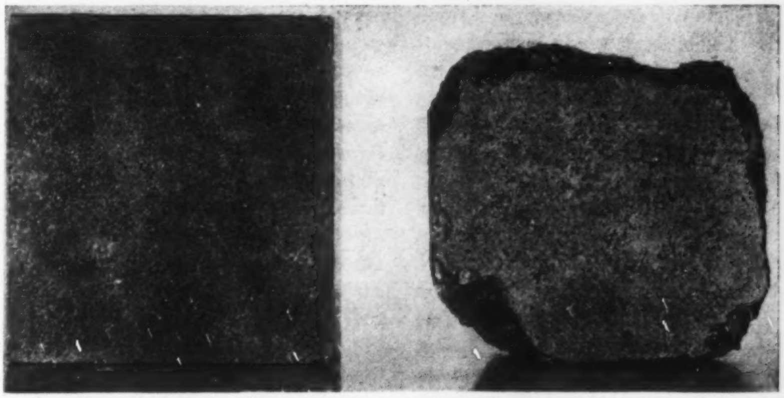


Fig. 4. After 50 cycles of freezing and thawing the block cast in ordinary forms (right) lost 22.6 per cent by weight. The block from the absorptive lined form lost nothing.

Fig. 5. Comparison of concrete surfaces obtained with regular forms with tongue-and-groove lagging and forms lined with the best absorptive board used in the Coulee Dam tests. Note typical air voids, sand streaking and water coursing on the wood formed surface.

problems. Protection of the board prior to its being covered with concrete constituted no problem, as a slight amount of wetting did not prove detrimental and in some cases appeared somewhat beneficial in providing a priming effect.

7. With most of the boards tried only a thin portion of the lining board next to the concrete was effective in absorbing water. The remainder of the ½-in. thickness was entirely dry when stripped.

8. A marked improvement in the smoothness and appearance of the exposed horizontal construction joints between concrete lifts, with complete absence of sand streaking and water coursing, was noted where absorptive lining was used.

9. The texture of the concrete surfaces formed with absorptive lining presented a pleasing effect from an architectural viewpoint.

10. Very few of the boards tested completely eliminated air voids under the overhanging forms. In some cases where surface elimination appeared satisfactory, numerous voids were found beneath a superficial surface layer of the concrete. This condition was to some extent a function of the vibration and compaction technique employed. All of the boards tried in the Coulee tests were effective in materially reducing the number of air voids as compared with wood-faced forms, and such voids as were formed with the use of absorptive lining were concentrated in areas at the tops of the concrete layers. (Each 5-ft. lift of concrete is placed in four layers.)

11. Improvement in the hardness of concrete surfaces placed against absorptive form lining, as measured by scratching, grinding and ball tests, was remarkable.

12. There was a tendency for the relatively dry, large-aggregate concrete to "hang up" on the comparatively rough lining board surfaces, but rock pockets were successfully avoided.

13. Rigid adherence to a fixed concrete vibration technique, which would probably vary with concrete characteristics and job conditions, is required.

14. Construction procedure was not complicated by the use of absorptive form lining.

So confident are the engineers that a satisfactory absorptive lining can be furnished that the Friant Dam specifications call for its use, and consideration is being given to such use at Shasta Dam. The former will require 1,500,000 sq.ft. of lining material.

Personnel

Research and design work of the Bureau of Reclamation is directed by J. L. Savage, chief designing engineer, and W. H. Nalder, assistant chief designing engineer. Arthur Ruettgers and R. F. Blanks head the materials, testing and control division of the Denver office, with E. N. Vidal in charge of the concrete and metals laboratory. C. O. Crane conducted most of the laboratory tests on absorptive form lining.

All activities of the bureau are supervised by John C. Page, commissioner, Washington, D. C., and all engineering and construction is under the direction of R. F. Walter, chief engineer, and S. O. Harper, assistant chief engineer, with headquarters in Denver.

• • •

More Roadside Parks For Michigan

Extension of its roadside parks, which already number 3,000, is announced by the Michigan state highway department, according to the American Public Works Association. Michigan was one of the first states to provide these convenient picnic places, which have become popular with motorists.

The cost of maintaining proper facilities at a roadside park for one season, including tables, garbage disposal, and landscape work, amounts to approximately $35. The highway department has set up certain requirements for the parks. They must have ample shade, absence of road curves, clear vision by approaching traffic, sufficient parking space off the highway, scenic views, no mosquitoes, no dust problem, and an accessible water supply.

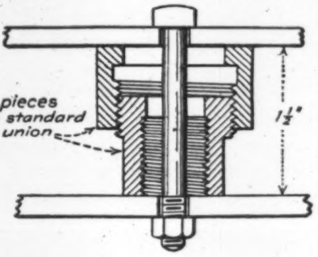
FROM FIELD AND OFFICE

Working problems and time-saving methods . . . Edited by Charles S. Hill

Scrap Unions Made Useful

W. F. SCHAPHORST
Newark, N. J.

While hunting around for something with a hole through it that could be used as a shim or block not long ago, I stumbled onto this useful kink. I was bolting some steel shelving onto a wall and in one place a gap of about 1½ in. had to be maintained rigidly. An old pipe union was in my odds-and-ends box and I utilized two of its three parts as shown in the accompanying sketch. The threads give a union the desired adjustable feature with a variation range of about half an inch. It served its purpose perfectly. It is substantial, looks good, and is not a temporary makeshift job. Large unions may be used as well as small, depending upon the fixed distance wanted. Where distances to be held are greater than the length of a union, a nipple and coupling can be used in the same way.



Pipe union used as spacer.

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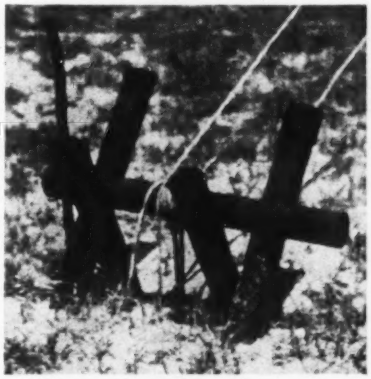
Adjustable Dead-man For Guy Wires

ELTON STERRETT
Longview, Tex.

Fabricated entirely from scrap 2-in. pipe and requiring no excavation, the illustration shows a satisfactory anchorage for guy wires that also permits adjustment of cable tension while in use.



Pipe dead-man allows guy line adjustment. Drifting sand has buried the lower "drum" of the dead-man.

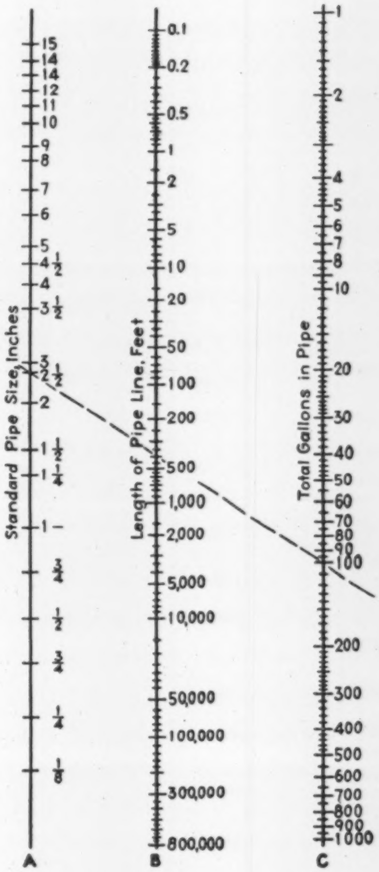
Four sections of pipe are driven into the ground to form two crosses about 2 ft. apart. The upper and lower angles of the crosses thus formed are usually around 60 deg., but they vary with the type of ground and driving difficulty. Into each of the vertical angles a short horizontal section of pipe is laid, and the guy cables stretched. The upper guy is led over the upper pipe, and wound on the lower; the lower guy passes under the bottom pipe and is wound on the upper. By means of holes in the projecting ends of the horizontal or drum sections, either guy can be tightened independently of the other, and the drum locked in position by extending the winding bar to engage with the projecting end of the other drum. To remove, the guy wires are released, and the four driven members are pulled out.

• • •

Gallons in Pipes

W. F. SCHAPHORST
Newark, N. J.

One often wants to know the volume of a given length of pipe in gallons. The writer does not know of any table that gives such values and where volumes are to be found they are usually given in cubic feet. Besides, the range of a table is seldom great enough to cover all desired conditions. The accompanying chart takes care of all of the standard pipe sizes from ⅛ in. to 15 in. in Column A, and any length of pipeline from 0.1 to 800,000 ft. in Column B. Column C shows volumes from 1 to 1,000 gal. this is enough to take care of most conditions.



In using the chart simply run a straight line through the pipe size (Column A) and the length of pipeline in Column B and the intersection with Column C immediately gives the total number of gallons in the pipe or pipeline. Thus the dotted line drawn across this chart shows that if the pipe size is 2½ in. (Column A) and the length of pipe is 400 ft. (Column B) the volume of the pipe (Column C), is 100 gal.

Or, if it is desired to know the length of pipeline required to hold a given number of gallons, or the size of the pipe necessary to hold a given number of gallons within certain limitations of length, the chart may be conveniently applied.

Here is another "trick": To determine the volume of a ½-in. pipe 1 ft. long, the easiest way is to run a line through the ½ in., Column A, and the 10,000 in Column B. The intersection with Column C says 160 gal., but that, of course, is for a pipeline 10,000 ft. long. By merely pointing off four places to the left we have 0.016 gal. as the volume of a ½-in. pipe 1 ft. long.

Notes on Sewage Disposal

A monthly summary of current developments conducted by Willem Rudolfs

BREWERY WASTE — Undiluted brewery and yeast plant wastes, although strong from a pollution standpoint, are too weak to justify expensive methods for recovery as stock feed constituents. They may be stabilized separately or in combination with domestic wastes, or recovered by concentration in multiple-effect evaporators, converted to feed or incinerated. Recently, (*Industrial and Engineering Chemistry,* 31, 1335, 1939) Boruff describes certain specialties which are being produced from this waste. Still molasses possesses a high pollution load (B.O.D. 22,000 ppm) and equipment is now in use in an industrial alcohol plant to de-alcoholize molasses beer and to concentrate the slop in a series of evaporators. The alcoholic concentrate is then rectified separately. Some is dried for chicken feed. Investigations to produce decolorizing carbon are underway. Undiluted still slop produced by the acetone-butanol fermentation of molasses (B.O.D. 7,000-11,000 ppm) is being concentrated, drum dried and sold to feed mixers as a source of vitamin G.

SULFITE LIQUOR—The problem of disposing of the waste sulfite liquor, which contains roughly half of the original wood, is complex and has been an active subject of investigation ever since the first sulfite mill was started in this country in 1886. The problem has been studied from many angles and close to a thousand patents have been issued on some phase of recovery. However, vast volumes of waste continue to be discharged, polluting many rivers. The productive capacity of sulfite mills in the United States is about 7,500 tons daily with an equal production of solid material in relatively dilute solution as waste. Skinner (*Industrial and Engineering Chemistry,* Nov., 1939) describes some of the outstanding developments in profitable utilization of waste liquor. Probably the most important development in reducing stream pollution has taken place within the past few years at the Marathon Paper Mill Co. in Wisconsin, where the Howard process for reuse of pulp and for recovery of chemicals and several valuable byproducts is employed. The process consists of fractional precipitation with caustic lime, resulting in three primary products; a calcium sulfite product for use in making fresh cooking acid; an organic product in solid form consisting of lignin used for fuel or as a chemical raw material; and an effluent less objectionable. The process does not involve evaporation, and strong liquor as well as dilute waste can be handled. One of the valuable by-products is a substance which has tanning properties, and is successfully being used by leather manufacturers.

INDUSTRIAL BYPRODUCTS — Even an incomplete summary of modern utilization of industrial wastes gives an impressive picture of the strides made. Howe and Van Antwerpen (*Industrial and Engineering Chemistry,* Nov., 1939) in presenting results accomplished provide a background for unsolved problems. Many wastes that are useless, difficult to handle, nuisance-producing, and costly to dispose of have been reclaimed or changed into valuable products. These include: manufacture of sulfuric acid and recovery of elemental sulfur from smelter gases; production of sulfuric acid from hydrogen sulfide in petroleum still gases; recovery of byproduct sulfur in illuminating gases; vanillin, carbon and other products from sulfite waste liquor; changing of waste casein into resins and adhesives; brewery and alcohol fermentation residues into cattle food; conversion of carbon-dioxide into dry ice; potash recovery from cement manufacture; making of building blocks from fly ash; soap produced from textile wastes, and many others.

There are many wastes which have been turned into usable products, such as the recovery of copperas from pickling liquors for use in sewage and water coagulation. Many other wastes can be reused, utilized or changed into commercial products by proper methods. Methods to reuse certain dyes, utilization of sulfite waste as boiler compounds, use of pickling liquor for paints, extraction of vitamins from fermentation wastes, and methane production from paper pulp practiced for many years by Kessener in Holland, are examples of further recovery and use. However, there are still many wastes which call for study and for the development of byproduct values. Co-operation between industries and research laboratories, together with public sentiment to reduce stream and air pollution will undoubtedly make utilization of industrial wastes still more important.

GAS FOR FUEL—Use of sludge gas for motor fuel is extending gradually. In England the present restrictions on gasoline caused the Middlesex Council (London) to place orders for a compressing plant where sludge gas from the Mogden treatment works will be prepared for operating vehicles. This gas has greater fuel value than coal gas and the cost of compressing the gas is far less than the cost of gasoline for equivalent power. It is planned to equip vehicles of the sewer department first and then extend the use of sludge gas to trucks and perhaps to vehicles of the London passenger transport board. The gas is particularly suitable in the operation of standard gasoline engines on account of its anti-knock properties; and at the same time it gives 40 per cent more energy than coal gas for the same value.

The London authorities plan to install two six-stage compressors, each of 100-cfm capacity, together with four high pressure storage cylinders, with a working pressure of 5,000 lb. per sq. in. Compressed gas stored in this way is to be transferred to smaller cylinders carried on vehicles. These will discharge through reducing valves into a mixing chamber and thence into the ordinary standard carburetor. It is estimated that the value of the gas so used will amount to more than $90,000 a year in addition to conserving gasoline supply during the war period.

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RIGHT: The new I. Magnin & Company building in Los Angeles is one of the most beautiful examples in the United States of just what Plyform will do. All of the surfaces on this structure except the flutings in the pilaster were formed against Plyform panels. Hunt & Chambers, architects. Wm. Simpson Co., contractors.

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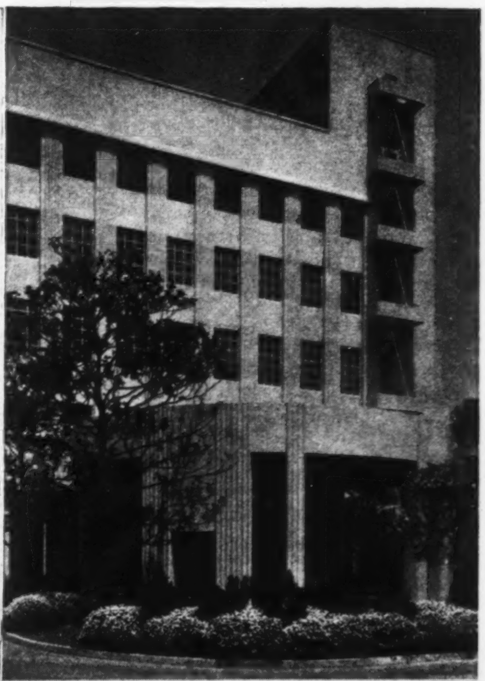
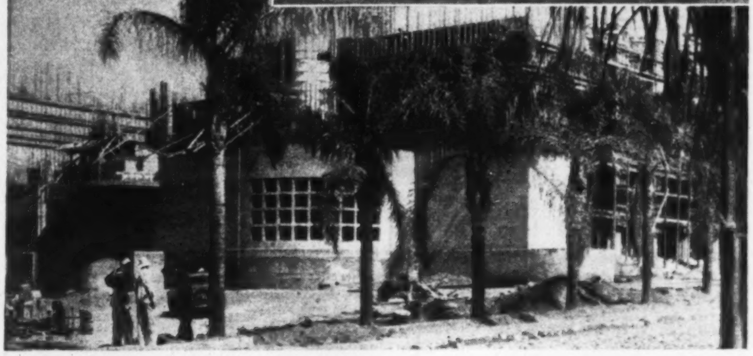
BELOW: The new Whittier High School in Whittier, Cal., shows how easily curved forms can be built of Plyform. In addition to the smooth surfaces on this job, Plyform gave numerous re-uses. William H. Harrison, Los Angeles, was architect.





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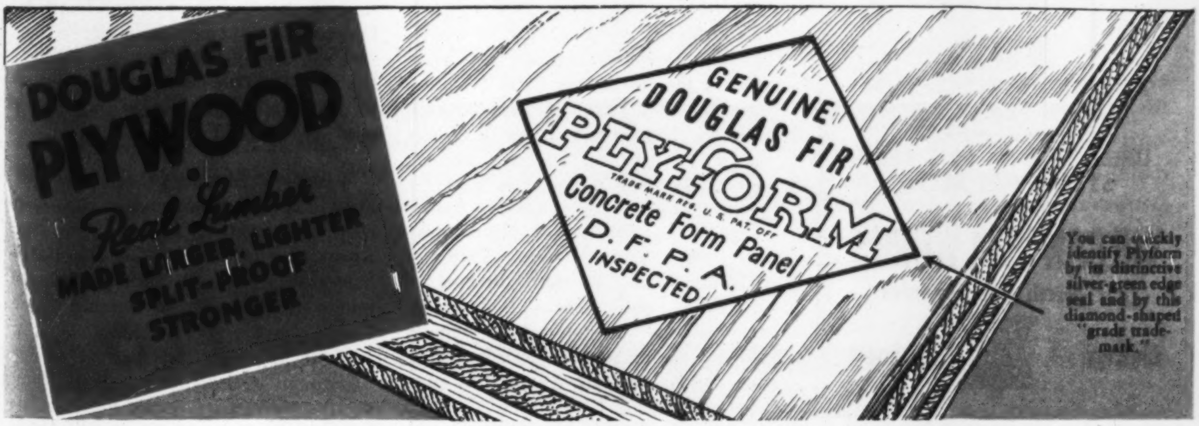

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MEN AND JOBS

Lieut. Col. Charles P. Gross, district engineer at Rock Island, Ill., U. S. Engineers, has been placed in charge of the field investigation necessary to determine the feasibility of the construction of flood control facilities on the Des Moines River.

J. W. Clayton, engineering graduate of the University of North Carolina, has been named engineer for Forsyth County, N. C. His headquarters will be at Winston-Salem.

Jorge Pena Polo, minister of Mexico's public works department, and **Jorge Gonzalez**, Mexican civil engineer, are making a study of Mexico's national highway system for the Mexican national highways commission.

Albert Shaw, vice president and general manager of the Lehigh & Hudson River Ry., has been elected president of the line to succeed **Morris Rutherford**. Shaw began his railway career with the New York Central in 1904 as a rodman. For a time he worked on the Reading R. R. and joined the Lehigh & Hudson in 1926. Rutherford, who had 57 years experience with the company, retired Jan. 1.

Charles L. Fox, civil engineering graduate of Rensselaer Polytechnic Institute, has been selected to succeed the late **W. C. Hawley** as general superintendent of the Pennsylvania Water Co. Fox was associated for 37 years with Hawley on maintenance and construction for the Pennsylvania Company.

George H. Duggan, chairman of the board of directors of the Dominion Bridge Co., Canada, has been made an honorary member of the Canadian Engineering Standards Association. He is also an honorary member of the American Society of Civil Engineers.

Norman A. Eager, engineering graduate of McGill and Cornell Universities, has been appointed assistant sales manager of the Burlington Steel Co. Ltd., Hamilton, Ont. Eager has been working with the Shawinigan Water & Power Co. as a structural engineer and on development and power sales work.

Frank L. Raschig of Middletown, Ohio, has succeeded **Carl Wahl**, of Defiance, Ohio, as state director of the Ohio Public Works Department. Raschig was assistant state highway director during the Cooper administration and he recently resigned as engineer in charge of Division 8 of the Ohio State Highway Department with headquarters at Middletown. **Parker S. Bookwalter**, of Dayton, Ohio, assistant division engineer, has succeeded Raschig. Bookwalter was once city engineer of Dayton, later engineer of Montgomery County, Ohio, and for a time served as field engineer for WPA in southeastern Ohio.

D. C. Peterson, who spent two years in Europe constructing and organizing a large tin plate mill for the Metal Box Co. of England, an affiliate of the Continental Can Co., has been named to succeed **E. D. Conant** as plant manager in charge of all manufacturing operations for the Buda Co., Harvey, Ill. Peterson has worked for the Buda Company before and during the past five years has been with Continental Can.

Linn White, consulting engineer, **John P. Ball**, senior civil engineer, and **Maurice N. Lovewell**, senior assistant engineer, Chicago Park District, all retired Dec. 31.

Ted M. Moody, formerly with the International Boundary Commission, McAllen, Tex., has resigned to become administrative assistant to the director of public works for the city of Dallas, Texas.

C. F. Izzard, assistant engineer with the Public Roads Administration and stationed at Austin, Tex., has taken a year's leave of absence to do graduate work in hydraulics at the University of Iowa.

Harry S. Andrews, Fulton, N. Y., former city engineer and commissioner of public works at Fulton, has returned to his old job to succeed **City Engineer George W. Hackett** and **Commissioner William E. Moon**.

James A. Hadley, until recently engineer for the west Tennessee division of the Tennessee State Highway Commission, is now employed as division engineer for the Mississippi State Highway Department with headquarters at Houston, Miss. Hadley began his new duties Jan. 1.

Walter V. Magee, graduate of Ohio State University, has been appointed chief construction engineer for the American Steel & Wire Co., Cleveland. Soon after leaving school, Magee joined the Youngstown Sheet & Tube Co., Zanesville. He left that firm in 1921 to go with the National Tube Co. Two years later he joined the engineering staff of American Steel.

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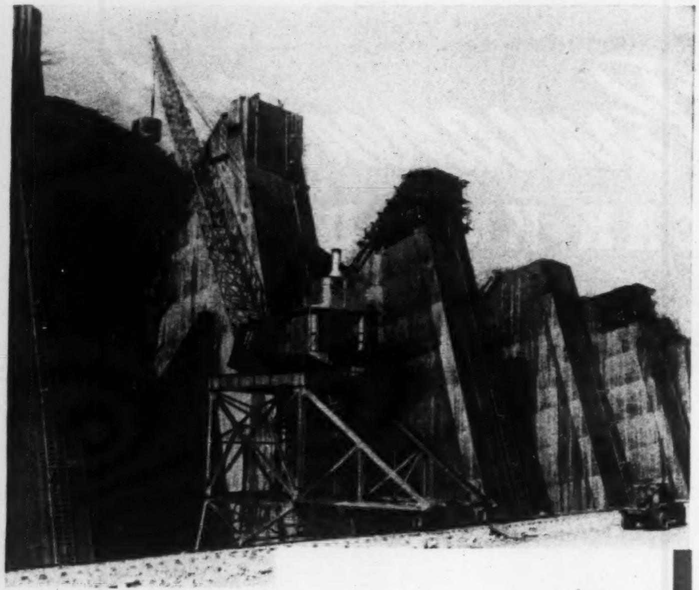

BIG dam IN OKLAHOMA

Battery of AMERICAN REVOLVERS Speed up work on the Big Pensacola Dam in the Grand River for Massman Construction Co.

AMERICAN REVOLVERS with 100-foot booms and mounted on 50-foot special traveling gantries are making a wonderful record on the Grand River Dam near Vinita, Oklahoma. On light loads the AMERICAN REVOLVERS are being run about three times as fast as they are supposed to and the vibration is so great that no glass will stay in the cab windows. However, the machines are standing the pressure magnificently and are the pride and joy of every man on the job.

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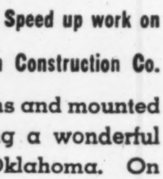
AMERICAN TERRY DERRICK CO.
SOUTH KEARNY, N. J.

See you at the road show.


INSIST ON THE RED U-BOLT

STANDARDIZE on the Genuine CROSBY CLIP for Safety
PERFECT GRIP . . . DROP FORGED STEEL . . . HOT GALVANIZED
safe since 1883

MEETINGS

American Shore and Beach Preservation Association, annual meeting, Hotel Carlton, Washington, D. C., Jan. 10.

National Air Conditioning Association, first annual convention, Hotel Stevens, Chicago, Ill., Jan. 15-17.

American Institute of Consulting Engineers, annual meeting, New York City, Jan. 15.

National Sand and Gravel Association, annual convention, Hotel Jefferson, St. Louis, Mo., Jan. 17–19. Concurrently, tenth annual convention of the National Ready-Mix Concrete Association.

Canadian Construction Association, Royal York Hotel, Toronto, Ont., Jan. 16-17.

American Society of Civil Engineers, annual meeting, New York City, Jan. 17-19.

American Society of Planning Officials, Chicago, Ill., January 18-19.

National Crushed Stone Association, Hotel Jefferson, St. Louis, Mo. Jan. 22-24.

National Society of Professional Engineers, Cincinnati, Ohio, Jan. 25-27.

American Institute of Planners, New York City, Jan. 25-26.

National Public Housing Conference, Washington, D. C., Jan. 26-28.

American Road Builders Association, Chicago, Jan. 29-Feb. 2.

National Paving Brick Association, annual meeting, Congress Hotel, Chicago, Ill., Jan. 30-31.

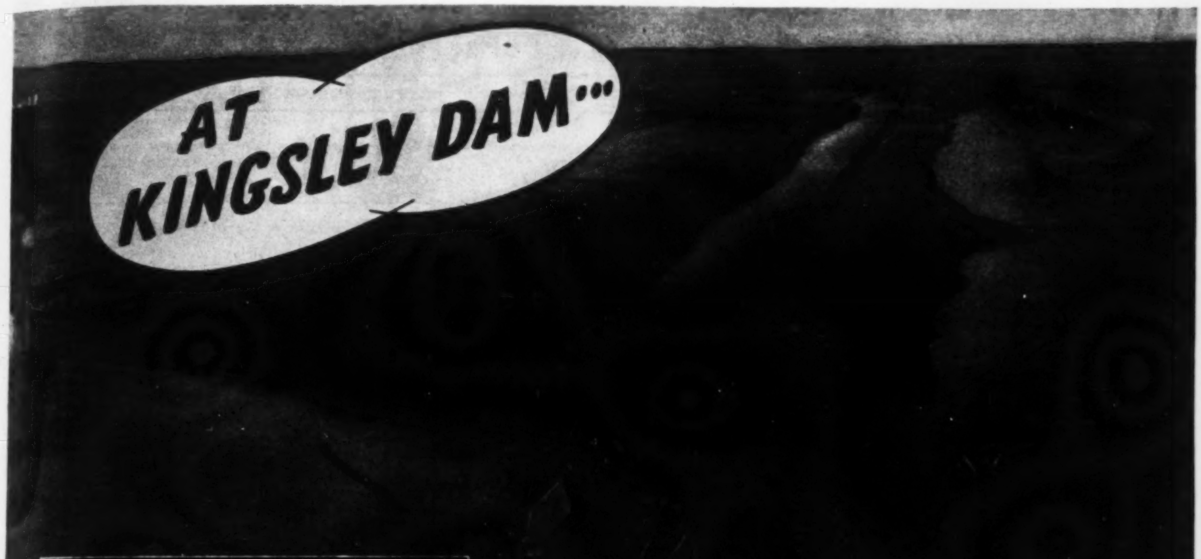
Associated General Contractors, National Convention, Peabody Hotel, Memphis, Tenn., Feb. 5-8.

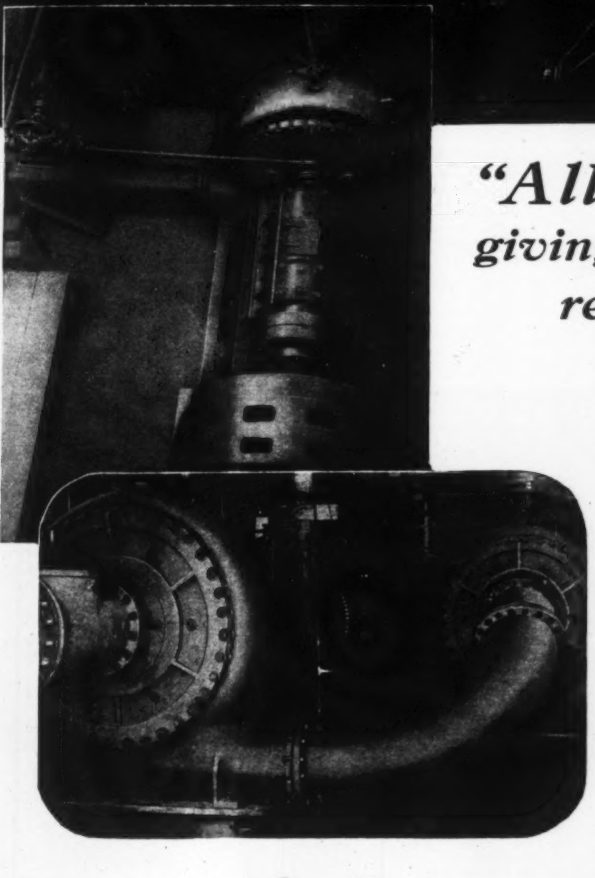
REGIONAL AND LOCAL

Associated General Contractors: North Dakota section, Grand Forks, N. D., Jan. 6. South Dakota section, Huron, S. D., Jan. 8-9. Central branch, Des Moines, Ia., Jan. 10-11. Missouri section, Kansas City, Mo., Jan. 18-19.

New York State County Highway

(*Continued on page 80*)





"*All* MORRIS *Pumps giving complete satisfaction" reports the Contractor*

The operation of the three 18-in. Morris Heavy-Duty Cast-Steel Dredging Pumps at the Kingsley Dam project has won high commendation from the contractors and engineers in charge.

Two of these pumps are located on a pump barge and operate in series, delivering 12,000 g.p.m. of dirty water containing abrasive solids, against a total head of 340 ft. to the hog or mixing box. The third 18-in. Morris Pump is located in a 30-ft. pit on top of a hill, drawing material from the bottom of the hog or mixing box and delivering through 11,000 ft. of 20-in. pipe line with static drop varying from 150 ft. to 10 ft. This pump handles approximately 25% of solids, delivering 800 cu. yd. of solids per hour. A Morris Slurry Pump is also used for priming the 18-in. pumps.

The experience of the contractors on this job confirms that of others all over the country—Morris Centrifugal Pumps and Dredges assure dependable, economical and troublefree pumping service.

Morris Machine Works, Baldwinsville, N. Y.

MORRIS

CENTRIFUGAL PUMPS

CONTRACT UNIT PRICES

What contractors are bidding on different kinds of construction work

WATER MAINS, KANSAS

OWNER: City of Wichita, Kansas; C. C. Ellis, City Clerk. Black & Veatch, Kansas City, Mo., engineers.

PROJECT: Constructing cast iron watermain to connect new wells with Wichita distribution system (Contract 6). Involves placing approximately 174,300 feet of cast iron water pipe, necessary fittings and specials, and valves.

CONDITIONS: Owner to furnish all cast iron pipe and all valves. Balance of materials to be furnished by contractor. Ground conditions good, sandy loam soil and level country. No rock formations anticipated. Project to be completed by May 18, 1940. Rail and highway transportation available. Wage rates are: skilled, $1.00 to $1.25 per hr.; semi-skilled, 60c. to $1.00; and common, 45c. per hr. Low bidder allowed 3½ per cent discount if awarded both sections of contract. As this was the case, total contract price should be $233,050. Unit prices are on the total amount, however, and no deductions have been made.

BIDS: Four bids were received on Section I, September 29, 1939, ranging from the contract low of $213,558 to $486,655. Eight bids were received on the same date for Section II, ranging from the contract low of $27,945 to $74,733.

SECTION I—PIPE LINES 30-IN. AND LARGER

LOW BIDDERS:

1. W. B. Carter, Wichita, Kan. (contract)	$213,558
2. Dobson & Robinson, Lincoln, Nebr.	251,453
3. S. E. Evans Constr. Co., Ft. Smith, Ark.	313,191

Item	Quan.	Unit Prices		
		(1)	(2)	(3)
1. 48-in. c. i. pipe, fittings, spec	93,100 l. f.	$1.33	$1.65	$2.05
2. 42-in. c. i. pipe, fittings, spec	27,200 l. f.	1.25	1.48	2.05
3. 36-in. c. i. pipe, fittings, spec	8,200 l. f.	1.15	1.24	1.89
4. 30-in. c. i. pipe, fittings, spec	7,300 l. f.	1.05	1.12	1.86
5. Crossing St. L. & S. F. RR	L.S.	3,190.00	2,850.00	3,000.00
6. Crossing A. V. I. RR. (3 times)	L.S.	525.00	360.00	450.00
7. Spec. vacuum release valve struct., sta. 100	L.S.	715.00	675.00	250.00
8. Spec. pres. relief valve struct	L.S.	1,772.00	1,675.00	1,000.00
9. Spec. valve control struct	L.S.	1,593.00	1,620.00	1,300.00
10. Spec. vacuum release valve struct., sta. 299	L.S.	750.00	715.00	250.00
11. Cone valve vaults	5 ea.	1,698.00	1,584.00	1,200.00
12. State highway crossing	L.S.	1,735.00	1,590.00	1,750.00
13. Air release valves and housing manholes	45 ea.	162.00	182.00	200.00
14. Blow-off installations	7 ea.	584.00	589.00	550.00
15. Blow-off drain lines	150 l. f.	1.78	1.80	2.00
16. Cl. C. conc. pipe cradles, etc	100 c. y.	10.00	12.00	20.00
17. Cl. C conc., anchorages, forms, bolts.	50 c. y.	16.50	15.00	20.00
18. Class B concrete	20 c.y.	12.00	10.00	15.00
19. Reinforcing steel	1,000 lb.	.06	.06	.05
20. Form work, complete	500 s. f.	.15	.12	.25
21. Concrete pavement (city)	100 s. y.	2.25	3.00	4.00
22. Pavmt., sh. asph. top, conc. base	50 s. y.	3.25	3.60	3.00
24. Pavmt., asph. conc. top, conc. base	50 s. y.	1.65	3.60	3.00
25. Haul and dispose excav. mat'l	100,000 sta. y.	.025	.035	.05
26. Replace sod	4,700 s. y.	.65	.60	.25

SECTION II—PIPE LINES 24-IN. AND SMALLER

LOW BIDDERS:

1. W. B. Carter, Wichita, Kan. (contract)	$27,945
2. Dobson & Robinson, Lincoln, Nebr.	34,521
3. Asplund Constr. Co., Enid, Okla.	39,325

Item	Quan.	Unit Prices		
		(1)	(2)	(3)
1. 24-in. c. i. pipe, fittings, spec	7,800 l. f.	$0.80	$1.03	$0.95
2. 20-in. c. i. pipe, fittings, spec	5,300 l. f.	.50	.82	.81
3. 14-in. c. i. pipe, fittings, spec	25,400 ft.	.45	.55	.76
4. Crossing railroads (2)	L.S.	1,247.00	1,185.00	1,190.00
5. Air release valve and housing manhole	3 ea.	162.00	156.00	135.00
6. Blow-off installations	1 ea.	478.00	452.00	500.00
7. 24-in. gate valve installation	1 ea.	557.00	570.00	625.00
8. 14-in. gate valve installation	23 ea.	192.00	220.00	215.00
9. Blow-off drain lines	20 l. f.	1.78	1.80	1.75
10. Class B conc	10 c. y.	12.00	10.00	18.00
11. Class C conc	15 c. y.	10.00	12.00	17.50
12. Reinforcing steel	1,000 lb.	.06	.06	.05
13. Form work	500 s. f.	.15	.12	.25

HIGHWAYS, NEW HAMPSHIRE

OWNER: New Hampshire State Highway Department, Concord, N. H.; John O. Morton, engineer.

PROJECT: Improving 3.648 miles of East Side Road in town of Gorham, Coos County, N. H. Most of project is 24 ft. wide, but .22 miles within urban limit involves improvement of two 16-ft. lanes. Surface treated crushed gravel type construction. Surface 4-in. thick.

CONDITIONS: Contractor to furnish all materials and complete project in 150 working days. Rail and highway transportation facilities available. Wage rates specified are: skilled, 75c. per hr.; semi-skilled, 50c. per hr.; and common, 40c. per hr.

BIDS: Eight bids were opened September 21, 1939, ranging from the contract low of $98,663 to $122,179.

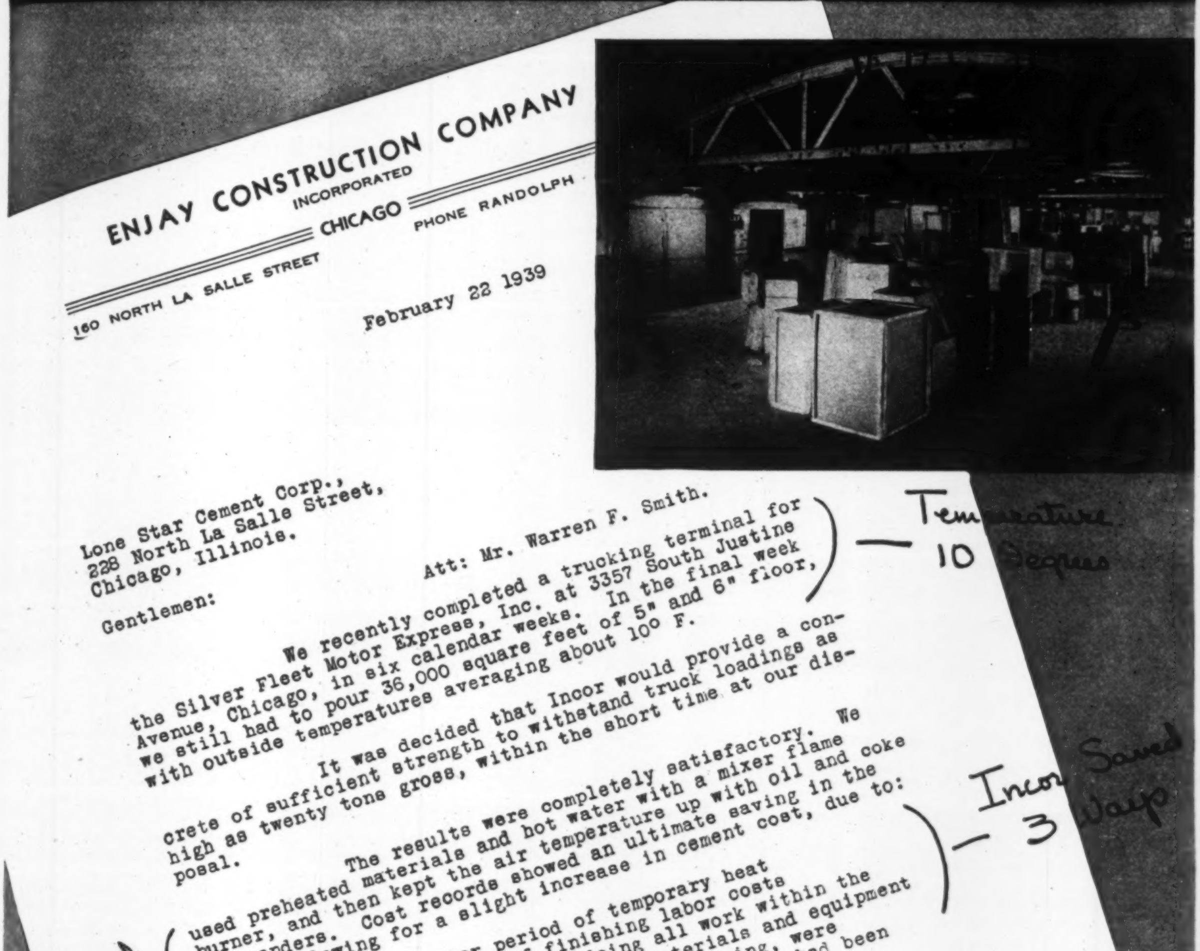
LOW BIDDERS:

1. John Iafolla Constr. Co., Dedham, Mass. (contract)	$98.663
2. Littleton Constr. Co., Littleton, N. H.	99.521
3. W. H. Hinman, Inc., North Anson, Me.	102.334

Item	Quan.	Unit Prices		
		(1)	(2)	(3)
1. Remove trees	130 ea.	$15.00	$5.00	$5.00
2. Remove abandoned rd. surf.	12,800 s. y.	.05	.10	.10
3. Unclassified excavation	44,993 c. y.	.32	.30	.30
4. Uncl. trench excav	2,630 c. y.	1.50	.75	.90
5. Uncl. channel excav	899 c. y.	.50	.30	.40
6. Uncl. struct. excav	644 c. y.	3.00	2.00	1.75
7. Earth borrow	1,000 c. y.	.25	.20	.30
8. Gravel borrow	14,500 c. y.	.32	.35	.35
9. Fine grading	120,500 s. y.	.02	.03	.025
10. Grav. borrow base course	23,200 c. y.	.32	.35	.40
11. Crushed grav. surf. crse	6,550 c. y.	.90	1.00	1.75
12. Cl. A bitum. surf. treatment	38,000 gal.	.15	.14	.14
13. Temp. bridge, 1-way traffic	L. S.	500.00	200.00	200.00
14. Remove superstructure	L. S.	500.00	500.00	350.00
15. Remove substructure	832 c. y.	1.50	1.00	1.75
16. Class A concrete	823 c. y.	18.00	17.00	17.00
17. Class B concrete	5 c. y.	18.00	16.00	17.00
18. Class C concrete	37 c. y.	16.00	16.00	17.00
19. Reinforcing steel	91,853 lb.	.0475	.05	.05
20. Mortar rubble masonry	68 c. y.	10.00	10.00	10.00
21. 12-in. std. str. rein. conc. pipe	324 l. f.	1.00	1.00	1.20
22. 15-in. std. str. rein. conc. pipe	544 l. f.	1.40	1.40	1.60
23. 18-in. std. str. rein. conc. pipe	72 l. f.	1.75	1.70	1.90
24. 24-in. std. str. rein. conc. pipe	172 l. f.	3.00	2.75	3.00
25. 30-in. std. str. rein. conc. pipe	176 l. f.	4.25	5.50	4.50
26. 36-in. std. str. rein. conc. pipe	64 l. f.	5.50	6.00	5.50
27. 42-in. std. str. rein. conc. pipe	76 l. f.	7.00	7.00	6.50
28. 12-in. vitr. clay pipe	152 l. f.	.75	2.00	.80
29. 8-in. spiral c.i. culv. pipe	874 l. f.	1.50	1.00	1.75
30. Bitum. coated corr. met. pipe	160 l. f.	1.00	1.00	1.25
31. Bridge railing, B	166 l. f.	5.00	4.00	3.00
32. Plant mix asph. bridge floor	26 ton	12.00	12.00	14.00
33. Paint waterproofing	216 s. y.	.40	.50	.20
34. Stone fill, B	130 c. y.	1.00	1.00	2.00
35. Straight granite curbing	740 l. f.	1.75	1.75	1.50
36. Curved granite curbing	30 l. f.	2.50	2.75	2.00
37. Straight rock faced gran. curb	1,635 l. f.	1.60	1.50	1.75
38. Curved rock faced gran. curb	130 l. f.	2.10	2.25	2.25
39. Cable guard rail (wood posts)	4,930 l. f.	.40	.38	.40
40. Wood guard rail (single rail)	210 l. f.	.60	.75	.50
41. Wood guard rail (double rail)	800 l. f.	.80	1.00	.60
42. Steel plate guard rail	270 l. f	1.30	2.00	1.50
43. Anchorages	44 ea.	10.00	10.00	9.00
44. Wood post markers	55 ea.	1.50	1.50	1.25
45. Catch basin, type A	29 ea.	85.00	75.00	60.00
46. Manholes	10 ea.	75.00	100.00	60.00
47. Rebuild manholes	17 ea.	25.00	50.00	25.00
48. Drop inlets, type B	10 ea.	60.00	50.00	60.00
49. Granite curb inlets	21 ea.	16.00	13.00	15.00
50. Metal drop inlets	13 ea.	20.00	15.00	15.00
51. Curb board	1,875 l. f.	.10	.10	.06
52. 3-in. pipe sleeve	100 l. f.	.75	1.00	.75
53. 3-in. conc. sidewalk	875 s. y.	1.50	2.00	2.00
54. Relay concrete sidewalk	300 s. y.	.50	2.00	1.25
55. Stock wire fence	6,000 l. f.	.15	.15	.15
56. Balanced stone wall	200 l. f.	.15	1.00	.40
57. Project markers	5 ea.	10.00	10.00	10.00
58. Maintain traffic	19,262 l. f.	.05	.05	.05
59. Loam, 2-in. deep	12,800 s. y.	.10	.20	.12
60. Loam, 4-in. deep	360 s. y.	.15	.30	.16
61. Loam, 6-in. deep	6,200 s. y.	.15	.30	.22
62. Sod	355 s. y.	.70	1.00	.50
63. Fertilizer for grasses	5,100 lb.	.08	.10	.05
64. Grass seed	430 lb.	.50	1.00	.50
65. 12-in. c. i. water pipe	172 l. f.	2.50	3.00	3.00

3 SAVINGS WITH 'INCOR'

ON COLD-WEATHER FLOOR JOB



ENJAY CONSTRUCTION COMPANY
INCORPORATED
160 NORTH LA SALLE STREET CHICAGO PHONE RANDOLPH

February 22 1939

Lone Star Cement Corp.,
228 North La Salle Street,
Chicago, Illinois.

Att: Mr. Warren F. Smith.

Gentlemen:

We recently completed a trucking terminal for the Silver Fleet Motor Express, Inc. at 3357 South Justine Avenue, Chicago, in six calendar weeks. In the final week we still had to pour 36,000 square feet of 5" and 6" floor, with outside temperatures averaging about 10° F.

Temperature 10 Degrees

It was decided that Incor would provide a concrete of sufficient strength to withstand truck loadings as high as twenty tons gross, within the short time at our disposal.

The results were completely satisfactory. We used preheated materials and hot water with a mixer flame burner, and then kept the air temperature up with oil and coke salamanders. Cost records showed an ultimate saving in the slabs, allowing for a slight increase in cement cost, due to:

Heat and Protection Supplied

1 Shorter period of temporary heat
2 Lowering of finishing labor costs
3 Possibility of doing all work within the building, since our materials and equipment at the final stages of pouring, were located on concrete slabs which had been poured a few days earlier.

Incor Saved 3 Ways

In addition to its standard uses we have availed ourselves of Incor in emergencies with splendid results.

Depend on Incor

The Silver Fleet Motor Express Job used 2229 bags of Incor Cement.

Yours very truly,
ENJAY CONSTRUCTION CO.

LONE STAR CEMENT CORPORATION

MAKERS OF LONE STAR CEMENT • • • 'INCOR' 24-HOUR CEMENT

MATERIALS AND LABOR PRICES

Market quotations on construction materials and wage rates reported monthly by ENR correspondents

JANUARY construction material prices show only minor changes from December. Short Leaf Yellow Pine is up $1.00 on all sizes in Baltimore and Cleveland. Pine is up $1.00 to $2.00 on most sizes in Montreal: and up $2.00 to $3.00 on 1- and 2 x 4-in. sizes in Denver, but off $2.00 to $3.00 on other 2-in. sizes there. Pine is down $1.00 in Chicago on the 2 x 10-in., and 50c. lower on 1-in. boards in St. Louis. Douglas Fir is $1.00 higher in Baltimore and up $1.00 on 1-in. sizes in Montreal. Chicago price on 2 x 10-in. is $1.00 lower.

Chicago cement price is down 15c. per bbl. and sand, gravel, and crushed stone prices are also 15c. per cu. yd. lower. Paving asphalt is off $1.00 per ton in Baltimore, Birmingham and Boston, and $1.50 per ton lower in New York.

Structural steel is off 20c. per 100 lb. in Detroit, and reinforcing bars are 25c. per 100 lb. lower there. Expanded metal lath is up 50c. per 100 sq. yd. in Baltimore and Chicago, but down 50c. in Cleveland.

Carpenters' rates in St. Louis now range from $1.25 to $1.50 per hr., whereas the $1.25 rate formerly prevailed. Hoisting engineers formerly received $1.57 to $2.00 per hr. in St. Louis, now the rate ranges from $1.75 to $2.00. The plasterers' rate there now ranges from $1.58 to $1.75 per hr.

Common labor rates remain unchanged from December.

CEMENT, AGGREGATES, READY-MIXED CONCRETE—F.O.B. CITY

	PORTLAND CEMENT Per bbl., carload lots, including 40c per bbl. for bags, cash discount not included			SAND AND GRAVEL Per ton, carload lots			CRUSHED STONE Per ton, carload lots		CRUSHED SLAG Per ton, carload lots, f.o.b. plant		CONCRETE Ready Mixed 1:2:4, 50 c.y. or more, delivered
	Cloth Bags*a*	Paper Bags	Bulk	Gravel, 1½ in.	Gravel, ¾ in.	Sand	1½ in.	¾ in.	1½ in.	¾ in.	
Atlanta	$2.90	$2.65	....	$1.75	$1.85	$1.95	$1.65	$1.75	$1.55	$1.65	$7.90
Baltimore	2.31	2.06	1.86	1.75‡	1.75‡	1.25‡	1.75‡	1.75‡	1.75‡	1.75‡	6.50
Birmingham	2.50	2.25	2.05	1.80	1.80	1.50	1.00	1.00	.90	1.15	5.80
Boston	2.75*b*	2.50*b*	2.30	1.10‡	1.10‡	.80‡	1.10‡	1.10‡	....	....	6.75*m*
Chicago	2.60	2.35	2.20	2.00‡*d*	2.00‡*d*	2.00‡*d*	2.00‡*d*	2.00‡*d*	1.25‡	1.25‡	....
Cincinnati	2.58	2.33	2.08	1.20	1.20	1.10	1.80	1.80	....	....	6.60
Cleveland	2.29	2.04	....	1.45*i*	1.45*i*	1.45*i*	1.70*i*	1.70*i*	1.70*i*	1.70*i*	6.85*i*
Dallas	2.30	2.05	1.85	2.00*p*	2.00*p*	1.50*p*	1.69*p*	1.84*p*	....	....	6.20
Denver	3.02	2.77	....	1.20	1.40	.90	....	....	....	....	7.25
Detroit	2.15	1.90	1.70	1.30	1.40	.81	1.45	1.45	1.14‡	1.14‡	6.50
Kansas City	2.56	2.31	2.16	1.85	2.30	1.00	1.91	1.91	....	....	7.90*n*
Los Angeles	2.82*b*	2.62*b*	....	1.00	1.00	1.00	1.00*f*	1.00*f*	....	....	5.85
Minneapolis	3.00	2.75	....	1.00*h*	1.00*h*	.25*h*	1.00*h*	1.00*h*	....	....	7.60*j*
Montreal	....	1.75*r*	1.60*r*	....	....	1.25‡	.85‡*c*	1.00‡*c*	....	....	7.60*l*
New Orleans	2.41	2.16	1.96	1.50	1.50	1.25	....	....	....	....	7.25
New York	2.60‡	2.35‡	....	1.40*de*	1.40*de*	.90*de*	1.65*de*	1.75*de*	....	....	7.25
Philadelphia	2.32	2.07	1.87	1.55‡	1.65‡	1.25‡	....	....	1.00	1.00	7.95*k*
Pittsburgh	2.44	2.19	1.99	1.80‡	1.80‡	2.10‡	2.25‡	2.25‡	1.50	1.50	8.75
St. Louis	2.55	2.30	....	1.50‡	1.50‡	1.25/1.50‡	.85*h*	.85*h*	.75*g*	.75*g*	7.50
San Francisco	2.72	2.52	2.20	1.36	1.36	1.36	1.46	1.46	....	....	7.63
Seattle	2.95*o*	2.70*o*	....	1.00*o*	1.00*o*	1.00*o*	2.00*o*	2.00*o*	....	....	7.50*o*

‡ Delivered. *a* 10c. allowed for each returnable bag. *b* 10c. per bbl. off for cash. *c* Plus municipal tax. *d* Per cu. yd. *e* Barge lots alongside docks *f* Crushed granite. *g* F.o.b. Granite City, Ill. *h* F.o.b. plant. *i* Within three miles of Public Square. *j* 5% discount for cash. *k* Discount 35c. 500 to 2000; 70c. 2000 to 5000; 95c. over 5000. *l* Up to 200 cu. yd. *m* 50c. off for cash. *n* 25 c.y. or more. *o* 2% off for cash. *p* 10c. per ton off, cash 15 days. *r* 10c. per bbl. off, cash 20 days.

CASH DISCOUNTS CEMENT to Contractors: truck delivery, 2% for cash on 10th of month; on carload deliveries, no trucking, same as dealer cash discount 10c. per bbl. for payment within 15 days of date of invoice. Subject discount 10c. per bbl. 20 days in Montreal.

CURRENT MAXIMUM PRICES RECEIVED AT CEMENT MILL

Charge for bags not included. For cloth bags, add 40c. per bbl.; 10c. refund allowed for each returnable bag; for paper bags add 15c. per bbl., not refundable

	Bagged	Bulk		Bagged	Bulk		Bagged	Bulk
Buffington, Ind	$1.70	$1.65	Ironton, Ohio	$1.60	$1.55	Richard City, Tenn	$1.80	$1.75
Dallas, Tex. (Inc. 5c. tax)	1.80	1.75	Limedale, Ind	1.70	1.65	Steelton, Minn	1.80	1.75
Hannibal, Mo	1.70	1.65	Norfolk, Va	1.65	1.60	Universal, Pa	1 65	1.60
Hudson, N. Y	1.75	1.70	Northampton, Pa	1.55	1.50	Waco, Tex. (5c. Tax in Tex.)	1.75	1.70
Independence, Kans	1.70	1.65	North Birmingham, Ala	1.70	1.65	Montreal	1.55	1.55

PAVING BRICK, BLOCKS, ASPHALT, ROAD OILS—F.O.B. CITY

	PAVING BRICKS AND BLOCKS			PAVING ASPHALT Per ton, less than 80 penetration		ASPHALT BINDERS — FLUXES Per gal. 80–300 penetration		CUTBACK ASPHALT Per ton		ROAD OILS Per gal.	ASPHALT EMULSION (Quick-breaking) Per gal.	
	Granite per M. lots of 50,000 4x4x8 in.	Brick per M. 3x4x8½ in. carload lots	Wood per sq. yd. 3½ in. 16-lb. treat	Tank car	Drums	Tank car	Drums	Tank car	Drums	Tank car	Tank car	Drums
Atlanta	$75.00	$39.35	$2.25	$16.60*e*	$21.80*e*	$0.0645*e*	$0.0945*e*	$0.0684*he*	$0.0984*h*	$0.0584*e*	$0.0644	$0.0684
Baltimore	145.00‡	44.00‡	2.75	14.00	20.00	.06	.09	.065*h*	.115*h*	......	......	......
Birmingham	......	28.50*j*‡	......	19.20	25.20	.0797	.1097	.0834*h*	.1334*h*	......	......	......
Boston	85.00	46.50	3.25	14.00	20.00	.06	.09	.065*h*	.115*h*	......	.09‡	.12‡
Chicago	145.00	50.00	1.80*d*	14.00	18.00	13.00*g*	17.00*g*	.055*h*	.10*h*	.035	.08	.12
Cincinnati	112.00	37.50	......	14.31	18.31	.10	......	18.00	......	.0525	.....	.08
Cleveland	110.00	37.50	2.80	15.25	20.50	.07	.08	.07*h*	.085*h*	.035	.08	.09
Dallas	......	30.00	......	13.25	20.30	.06	.103	15.00	24.80	.055	.05/.07	.07/.09
Denver	......	27.50	......	......	......	......	......	......	......	......	......	.....
Detroit	......	35.00	......	13.60*f*	18.00*f*	.0593	.0994	13.60	18.00	.0535	.0507	.0924
Kansas City	......	44.00	......	18.50	23.50	.077	.1075	.077*h*	.107*h*	.057	.11	.15
Los Angeles	......	50.00	......	6.50*b*	15.00	6.50*bg*	15.00*bg*	5.50*b*	......	.0192	.0525	.1125
Minneapolis	......	......	1.90*d*	19.20	24.20	.10	.12	19.30	28.30	.056	......	.....
Montreal	75.00	......	3.62	14.60	21.25	.105	.1375	.101*h*	.121*h*	.07	.13	.16
New Orleans	......	......	......	14.00*a*	19.00*a*	.055	.085	.06*h*	.09*h*	......	.078	.....
New York	......	68.00	2.75	15.00	21.00	.06	.09	.065*h*	.115*h*	......	.07	.11
Philadelphia	120.00	42.50	2.84	14.00	19.00	.055	.08	.06*h*	.09*h*	.05	.06	.09
Pittsburgh	120.00	40.00	......	......	......	......	......	......	......	......	......	.....
St. Louis	110.00/121.00	37.00	......	14.00	19.00	14.00*g*	19.00*g*	.06*h*	.095*h*	.04	.09	.125
San Francisco	......	70.00	......	6.50	15.00	6.50*g*	15.00*g*	7.00	17.50	.025	.0475	.117
Seattle	......	60.00*c*	......	13.71	23.51	......	24.11*g*	10.11/11.11	23.61/24.61	8.36*g*	.0575*i*	.1308

‡ Delivered. *a* F.o.b. Baton Rouge. *b* Delivered to purchaser's warehouse. *c* 3½x4x8½ in. *d* 2½ in. 6 to 8-lb. treatment. *e* Local reduction due to 20% reduction intra-state class freight rates, only Georgia affected. *f* Mexican. *g* Per ton. *h* Per gallon. *i* F.o.b. Martinez. *j* 3x3⅝x8½ in.

IRON AND STEEL PRODUCTS—BASE MILL PRICES

	STRUCT. SHAPES-PLATE	REINF. BARS ¾-in. billet *b*	RIVETS ¾-in. structural	WIRE NAILS Base *d*	SHEET PILING Base	STEEL RAILS Per Gross Ton			TRACK SUPPLIES			
						Standard	Light	Re-rolled	Angle Bars	Std. Spikes *c*	Tie Plates *c*	Track Bolts
Birmingham	$2.10	$2.15	$3.40	$2.55	....	$40.00	$40.00	$39.00	$2.70	$3.00	$2.15	$4.15
Chicago	2.10	2.15	3.40	2.55	$2.40	40.00	40.00	39.00	2.70	3.00	2.15	4.15
Pittsburgh	2.10	2.15	3.40	2.55	2.40	40.00	40.00	39.00	2.70	3.00	2.15	4.15
Buffalo	2.10	2.15	....	....	2.40	....	....	....	....	....	2.15	....
Cleveland	2.10	2.15	3.40	2.55	....	....	....	....	....	....	....	....
Youngstown	....	2.15	....	....	....	....	....	....	....	3.00	....	....
Detroit	....	2.25‡	....	....	....	....	....	....	....	....	....	....
Gulf ports	2.45*a*	2.50*a*	....	....	2.85*a*	....	....	....	....	....	....	....
Pacific ports	2.70*a*	2.60*a*	....	....	2.90*a*	....	....	....	....	3.00	2.25	....

‡ Delivered. *a* F.o.b. cars dock. *b* Rail steel same as billet prices. *c* Other basing points include Portsmouth, O., Weirton, W. Va., St. Louis, Kansas City, Minnequa, Colo., and Pacific coast ports, on tie plates alone, Steelton, Pa., on spikes alone, Lebanon, Pa., Richmond, Va. *d* Add switching charge $18 per c.l.

IRON AND STEEL PRODUCTS—F.O.B. WAREHOUSE, PER 100 LB., BASE PRICE

	STRUCTURAL SHAPES	REINFORCING BARS* Per 100 lb., ¾ in., base price				EXPANDED METAL LATH —Per 100 sq.yd., carload lots		WELDED FABRIC REINFORCING —Per 100 s.f., carload lots			SHEET PILING
	Per 100 lb., base price	15 tons or over *b* New billet	Rail steel	Add Switch	$/cwt. for Del.	Std. diamond mesh, 3.4 lb.	Std. ribbed 3.4 lb.	4x16 in., No. 5 & 10 wires	4x12 in., No. 8 & 12 wires	6x6 in. No. 6 & 6 wires Per sq. yd.	Per 100 lb. base price
Atlanta	$2.34	$2.39	$2.39	.02½	.10	$21.00	$23.00	$1.82	$1.35	$0.1719	$3.04
Baltimore	3.60	2.85	2.70	......	.10	21.00	23.00	1.70	1.27	.1611	2.75
Birmingham	2.10*a*	2.15	2.15	.02½	.10	19.50	21.50	1.80	1.34	.1701	....
Boston	4.00	2.73	2.58	$20 C.L.	.10	21.50	23.50	1.76	1.31	.1656	3.14
Chicago	2.10*a*	2.15	2.15	.03	.05	19.00	21.00	1.67	1.25	.1575	2.40
Cincinnati	3.68	2.51*c*	2.51*c*	......	.05	20.50	22.50	1.66	1.25	.1566	....
Cleveland	3.58*g*	2.15	2.15	.02½	.10	20.50	22.50	1.66	1.25	.1566	....
Dallas	4.75	3.25	3.25	......	......	25.00	27.00	1.93	1.42	.1827	....
Denver	4.35	3.95	3.80	......	......	23.50	25.50	1.97	1.45	.1863	....
Detroit	3.60‡	2.35	2.20	......	.10	22.50	24.50	1.68	1.26	.1584	2.66
Kansas City	4.03	2.51*c*	2.36*c*	.0	.05	18.50	20.50	1.78	1.33	.1683	2.86
Los Angeles	3.65*f*	2.65	2.50	.02½	.05	23.00	27.50	1.93	1.42	.1827	3.65
Minneapolis	3.80‡	2.48*c*	2.48*c*	.0	.10	21.50	24.50	1.80	1.34	.1701	2.73*d*
Montreal	3.80	2.65	2.55	......	......	26.00	28.50	2.99	2.08	.319	3.95
New Orleans	4.40	2.52	2.52	.05	.10	21.50	23.50	1.82	1.35	.1719	2.875
New York	3.75	2.39	2.39	......	.10	20.50	22.50	1.76	1.32	.1665	2.74
Philadelphia	3.55	2.66	2.56	......	......	19.50	21.50	1.71	1.28	.1611	2.72
Pittsburgh	2.10*a*	2.15	2.15	.02½	.10	21.50	24.50	1.59	1.20	.1503	2.40
St. Louis	3.47	2.39	2.39	.0	.05	20.50	24.00	1.69	1.27	.1602	2.70
San Francisco	4.00	2.525	2.375	.02½	.10	23.50	25.50	1.93	1.42	.1827	3.25
Seattle	2.70*e*	2.40*e*	......	......	......	25.50	27.50	1.93	1.42	.1827	2.90*e*

‡ Delivered. *a* Mill prices. *b* 5–15 tons, add 15c. 1–5 tons, add 25c. Less than 1 ton, add 50c. *c* 20 tons or over Base. *d* Mill price plus freight. *e* F.o.b. dock. *f* Includes delivery in free delivery zone. *g* Less than 1 ton, add 30c.; 1 to 5 tons, add 10c. * High scrap steel prices cut former 15c. differences between new billet and rail steel in many mills.

PLUMBING, HEATING, WATER, SEWER AND DRAIN PIPE

	C. I. PIPE	VITRIFIED SEWER PIPE				CLAY DRAIN TILE		CONCRETE SEWER PIPE		WROUGHT STEEL PIPE Full standard weight, *h*			
										1 to 3 in., Butt Weld		3½ to 6 in., Lap Weld	
	Per net ton f.o.b. 6 in. to 24 in.*a*	Per foot, 8 in., s.s.	delivered 12 in., s.s.	ASTM 24 in., d.s.	C13–35 36 in., d.s.	Per 1,000 ft., carload lots, 6 in.	f.o.b. 8 in.	Per ft., delivered: ASTM 12 in.	C 14–35 24 in.	Black %	Galv. %	Black %	Galv. %
Atlanta	$49.40	$0.26*bc*	$0.468*bc*	$1.8525	$4.68*c*	$85.00	$128.00	$0.45	$1.625	62.2	54.2	59.7	51.2
Baltimore	52.80	.30	.55	2.30	6.80	110.00	150.00	.40	1.60	65.5	57.5	63.0	54.5
Birmingham	45.00	.26	.468	1.854	4.66	85.00	220.00	.40	1.60	62.2	54.2	59.7	51.2
Boston	55.00	.294	.567	2.16	6.15	199.00‡	288.00‡	.50	2.50	64.1	56.1	61.6	53.1
Chicago	53.80	.28	.54	2.25	6.25	100.00‡	150.00‡	.38	1.48	67.0	59.0	63.5	55.0
Cincinnati	52.70	.259	.4995	1.935	5.6375	75.00	120.00	.60	1.90	65.9	57.9	63.4	54.9
Cleveland	54.24	.21	.405	1.575	4.8175	69.00	108.00	.35	1.50	67.8	59.8	65.3	56.8
Dallas	58.20	.265	.477	1.728	4.70	80.00	100.00	.46	1.57	59.9	51.9	57.3	48.3
Denver	60.60	.24†	.52†	2.16†	......	130.00	240.00	......	......	58.4	50.4	55.7	47.2
Detroit	54.24	.147	.2835	1.215	4.70	66.45	111.40	.20	1.125	66.3	58.3	63.8	55.3
Kansas City	55.12	.30	.54	2.16	5.00	120.00	240.00	.45	1.60	62.9	54.9	60.0	51.5
Los Angeles	55.00	.282†	.508†	2.034†	5.085†	115.50	192.50	1.00	2.00	56.8	47.8	54.3	44.8
Minneapolis	57.20	.24†	.432†	1.728†	4.60†	......	......	.70	1.80	64.2	56.2	60.7	52.2
Montreal	60.00	.55	.90	3.15	5.10*e*	135.00‡	260.00‡	.48	1.92	......	......	......	......
New Orleans	51.38	.26	.48	1.69	......	150.00	220.00	.37	2.10	62.4	54.4	58.8	50.3
New York	52.20	.32	.63	2.52	6.45	......	......	.50	1.20	64.9	56.8	62.4	53.9
Philadelphia	50.90	.21	.405	1.75	5.05	100.00	160.00	.54	1.80	65.3	57.3	62.8	54.3
Pittsburgh	55.60	.245†	.4725†	1.845†	5.4325	97.80	154.20	.85*g*	2.00*g*	68.5*i*	60.5*i*	66.0*i*	57.5*i*
St. Louis	52.48	.28	.504	2.016	4.84	100.00	230.00	.75*j*	1.80*k*	65.1	57.1	62.0	53.5
San Francisco	55.00	.3275*d*	.5895*d*	2.358	5.895	107.25	178.75	.45	2.50	......	......	......	......
Seattle	55.35	.35	.63	2.52	6.30	72.00	175.00	.45*f*	1.40*f*	......	......	......	......

‡ Delivered. † F.o.b. *a* B. & S. class B and heavier, C/L lots, 200 tons and over Burlington, N. J. (base) $49.00. Gas pipe and class A, $3 per ton additional, 4 in., $3 per ton additional, 30 in. and larger usually $2 per ton less. *b* Double strength. *c* List to dealer. *d* List. *e* 30-inch. *f* Less 5% for cash. *g* Culvert pipe. *h* Discounts from standard list consumers carload prices, except Pittsburgh prices are f.o.b. mill. Base price $200 per net ton. List prices per ft.: ½ in., 8½c.; ¾ in., 11½c.; 1 in., 17c.; 2 in., 37c.; 2½ in., 58½c.; 3 in., 76½c.; 4 in., $1.09; 6 in. $1.92. *i* Applies also at Lorain, Ohio, mills. Chicago delivered base is 2½ points less.

Freight is figured from Pittsburgh, Lorain, O., Chicago Dist. Billing is from point producing lowest price at destination. WROUGHT IRON PIPE: Base price and list prices per ft. same as wrought steel pipe. Discount for Pittsburgh base: Butt-weld — 1 in. and 1¼ in. black 24, galv. 19; 1½ in. black 38, galv. 21½; 2 in. black 37½, galv. 21. Lapweld — 2½ in. to 3½ in. black 31½, galv. 17½ in.: 4½ in. to 8 in. black, 32½ galv. 20. *j* Reinforced; spec. C 76-37. *k* Reinforced; spec. C 75-37.

LUMBER, TIMBER, PLYWOOD—PER M FT. B.M., CARLOAD LOTS F.O.B.

	SHORT LEAF YELLOW PINE AND DOUGLAS FIR — **All S. L. Y. P. is No. 2 common or better and for No. 1 N. C. Box. (Prices in Bold Face)** *All Fir planks No. 2 common; Fir timber is No. 1 common. Lengths up to 20 ft. (Prices in italics)*									LONG LEAF Y. P. Merchantable grade up to 20 ft.		PLYWOOD* Rail freight increment (See note for base price)	
	1x6,^{S4S}	1x8,^{S4S}	2x4,^{S4S}	2x6,^{S4S}	2x8,^{S4S}	2x10,^{S4S}	3x12,^{Rgh}	6x12,^{Rgh}	12x12,^{Rgh}	2x12,^{Rgh}	12x12,^{Rgh}	⅝"	¾"
Atlanta	**$19.00**	**$19.00**	**$18.00**	**$20.00**	**$19.50**	**$21.00**	**$26.00**	......	......	$37.50	$50.50	$17.75	$21.60
Baltimore	**30.00**	**31.50**	**36.50**	**35.50**	**36.00**	**37.00**	**44.50**	......	......	67.00	68.00	17.35g	21.15g
	32.00	*32.00*	*34.00*	*33.00*	*34.00*	*34.00*	*44.50*	*$44.50*	*$40.00*	......	......	......	......
Birmingham	**22.50**	**23.50**	**22.00**	**21.00**	**22.00**	**23.00**	**37.00**	**36.00**	**36.00**	......	......	16.25	19.85
[1]	25.50	25.50	29.00	27.00	29.00	40.00	60.00	......	......	54.00	57.00	......	......
Boston	32.00[2]	32.00[2]	34.00[3]	34.00	53.00[1]	63.00[1]	77.00[1]	......	......	77.00	77.00	17.35g	21.15g
	29.00	*29.00*	*34.00*	*34.00*	*36.00*	*36.00*	*45.00*	*45.00*	*50.00*	......	......	......	......
Chicago	**33.00**	**33.00**	**34.00**	**34.00**	**34.00**	**34.00**	**50.00**	......	......	80.00	90.00	13.15	16.05
	37.00	*37.00*	*40.00*	*38.00*	*40.00*	*40.00*	*44.00*	*43.00*	*43.00*	......	......	......	......
Cincinnati	**31.50**	**33.00**	**30.50**	**31.00**	**32.00**	**35.00**	**44.50**	......	......	53.00	56.00	16.25	19.85
	......	......	......	......	......	......	*46.00*	*46.00*	*46.00*	......	......	......	......
Cleveland	**34.00**	**34.50**	**34.00**	**34.50**	**36.00**	**38.00**	**45.00**	46.00	46.00	80.00	80.00	16.65	20.25
Dallas e	**28.50**	**32.00**	**31.50**	**29.00**	**30.50**	**32.50**	**52 50**	**52.50**	**52.50**	63.50	71.00	13.90	16.95
Denver ‡	47.00[4]	45.00[4]	42.00[4]	40.00[4]	40.00[4]	41.00[4]	48.00[4]	60.00[4]	71.50[4]	......	......	9.90	12.05
Detroit	**35.00**	**35.00**	**35.00**	**35.00**	**38.50**	**42.00**	**46.00**	......	......	43.50	58.00	16.25	19.85
	......	......	......	......	......	*46.00*	*47.00*	*54.00*	*54.00*	......	......	......	......
Kansas City	**29.00**	**31.00**	**30.00**	**28.50**	**29.00**	**31.00**	**35.00**	......	......	55.00	60.00	12.25	14.95
	29.00	*30.00*	*30.00*	*28.50*	*29.00*	*30.00*	*35.00*	*39.00*	*39.00*	......	......	......	......
Los Angeles a	*36.00*	*35.00*	*36.00*	*33.00*	*33.00*	*33.00*	*38.00*	*46.00*	*39.00*	......	......	9.35gh	11.35gh
Minneapolis ‡b	47.00[6]	47.00[8]	......	......	......	......	......	......	......	......	......	12.05	14.70
‡	*38.00*	*38.00*	*39.00*	*39.00*	*39.00*	*39.00*	*59.00*	*59.00*	*59.00*	......	......	......	......
Montreal [7]	*46.00*	*46.00*	*49.00*	*49.00*	49.00	58.00	85.00	......	......	155.00	165.00	......	......
	41.00	*41.00*	*40.00*	*40.00*	*40.00*	*42.00*	*42.00*	*40.00*	*40.00*	......	......	......	......
New Orleans	**24.00**	**25.00**	**25.00**	**24.00**	**24.00**	**25.00**	**46.00**	......	......	62.00	69.00	13.90	16.95
	29.00	*29.00*	*32.00*	*33.00*	*35.00*	*34.00*	*36.00*	......	......	......	......	......	......
New York ‡	**38.00**	**39.00**	**37.00**	**38.00**	**38.00**	**39.00**	**42.00**	......	......	80.00f	82.50f	17.35g	21.15g
‡	......	......	*45.00*	*45.00*	*45.00*	*45.00*	*45.00*	*47.50*	*47.50*	......	......	......	......
Philadelphia	**24.00**	**24.50**	**25.50**	**25.50**	**27.50**	**27.50**	**29.00**	......	......	50.00	57.50	17.35g	21.15g
	35.00	*36.50*	*39.00*	*38.25*	*39.00*	*39.00*	*44.00*	*32.00*	*32.00*	......	......	......	......
Pittsburgh	**38.10**	**39.90**	**47.05**	**42.00**	**45.65**	**46.90**	**59.70**	......	......	......	......	17.00	20.70
	51.90	*49.60*	*49.60*	*49.00*	*48.90*	*49.25*	*66.55*	*66.55*	*66.55*	......	......	......	......
St. Louis ‡c	**32.50**	**33.50**	**32.00**	**31.00**	**32.00**	**33.00**	**48.00**	*52.00*	*52.00*	73.00	72.00	13.90	16.95
San Francisco d	*22.50*	*22.00*	*22.50*	*22.50*	*21.50*	*21.50*	*23.50*	*23.50*	*23.50*	......	......	7.30g	8.90g
Seattle	*21.00*	*21.00*	*21.00*	*21.00*	*21.00*	*21.00*	*26.00*	*26.00*	*26.00*	......	......	0.00	0.00

Bold Face type, Southern Pine. *Italics, Douglas Fir.* [1] Long leaf. [2] Roofers' N. C. Pine. [3] Spruce. [4] Native. [6] Western Pine, No. 3 Common. [7] Pine. [8] Norway Pine. ‡ Delivered. *a* Yard prices. *b* Contractors discount in Minneapolis and St. Paul discontinued May 21, 1938. *c* 5M ft. or less. *d* At ship's tackle. *e* 10% discount taken off. *f* Up to 18 ft.

Note: Special concrete form grade Fir Plywood, 4′ by 8′ panels, 5-ply, sanded 2 sides, water resistant glue, carload lots, delivered per 1,000 sq. ft. surface. Seattle base price on ⅝", $77.00; on ¾", $84.80; price includes oiling and sealing charges. For other centers add rail freight increment from table for proper size. For resin dipped treatment, add $10.00 per M. *g* Lower rate by water shipment. *h* 50,000 lb. minimum.

* Manufacturers pretty well sold for first quarter; deliveries expected to be slow.

GLASS, EXPLOSIVES, CHEMICALS

	WINDOW GLASS — Discounts from jobbers list, Sept. 15, 1928 Single or Double Thickness A quality	B quality	EXPLOSIVES — Per lb. 40% Ammonia Gelatin in 50-lb. cases delivered in 200 lb. lots*
Atlanta	75%*d*	75%*d*	$0.15
Baltimore	83%*d*	82%*d*	.15
Birmingham	89%	85%	.105
Boston	82%*d*	82%*d*	.15
Chicago	79%*d*	79%*d*	.15
Cincinnati	79%*d*	79%*d*	.15
Cleveland	88-10-10%	88-10-10%	.19
Dallas	78%*d*	78%*d*	.165
Denver	76-10%*d*	76-10%*d*	.15*e*
Detroit	79-10%*d*	79-10%*d*	.15
Kansas City	79-10%*d*	79-10%*d*	.155
Los Angeles	86%	88%	.1575
Minneapolis	76%*d*	76%*d*	.155
Montreal	70-10%*ab*		.17†
New Orleans	70%*d*	75%*d*	.16
New York	82%*d*	83%*d*	.20*f*
Philadelphia	82-10%	83-10%	.15
Pittsburgh	79%*d*	79%*d*	.1425
St. Louis	79-10%*d*	79-10%*d*	.155
San Francisco	78%	83%	.155
Seattle	85%	88%	.1575

Price of 60% Ammonia Gelatin is $0.015 per lb. higher than 40%

a Disc. from list Sept. 1939. *b* Also less 6% tax exemption. *d* Discount from jobbers' list Aug. 15, 1938.

* Urban prices influenced by service charges or local storage and delivery regulations, do not consistently reflect quantity prices in less congested areas. *e* F.o.b. Louviers, Colo. *f* In boroughs of Kings, Queens and Richmond, and in Manhattan south of Canal Street, add delivery charge of $6.00 per trip. † F.o.b.

40% Ammonia Gelatin price ranges in other than urban areas, per lb. (except Seismograph Grades)

	C/L 20.000 lb. net	Tons	200 lb. lots
E. of the Miss., except Fla.	$0.105	$0.14	$0.16
W. of Miss., to Rocky Mtn. States, and Fla.	.11 -.12	.135 -.15	.155 -.17
Rocky Mtn. States	.11 -.1325	.13 -.145**	.15 -.165**
Pacific N. W. States	.1075-.115	.1375-.15	.1575-.17
Pacific S. W. States	.1050-.1175	.135 -.1475	.155 -.1625

** F.o.b. Louviers, Colo., or Butte, Mont.

PILES, TIES—F.O.B.

PILES

Prices per linear foot, pine, with bark on, f.o.b. New York; delivered from barge 1½ to 2c. per ft. additional:

Dimensions	Points	Length	Short Leaf — Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.18	$0.195
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.225	.24
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.23	.255
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.24	.265
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.28	.275
14 in.—2 ft. from butt	5 in.	80 to 85 ft.	.40	.415
14 in.—2 ft. from butt	5 in.	85 to 89 ft.	.42	.482

RAILWAY TIES

Prices f.o.b., per tie for carload lots:		6" x8" x8′ Untr.	Tr.	7" x 9" x8′6" Untr.	Tr.
Boston	Oak	$1.20	....	$1.65	....
	Pine	1.50	$2.25*a*	2.25	$3.20*a*
New York	S. L. Sap Pine	1.10/1.20	1.85	1.50	2.35
	Mixed Oak	1.45	1.95	1.90	2.45
Birmingham	White Oak	.85	1.50*a*	1.35	1.70*a*
	Southern Pine	.55*b*	1.10*ab*	.70	1.30*a*
Chicago	Oak	....	1.65*a*	....	2.25*a*
	Southern Pine	....	1.53*a*	....	2.13*a*
Los Angeles	Douglas Fir	.64	1.38*a*	.90	1.80*a*
Philadelphia	Red Oak	1.10	....	....	2.40*a*
St. Louis	White Oak	1.12	....	1.50	....
	Red Oak	1.12	1.60*a*	1.50	2.03*a*
	Sap Pine or Cypress	1.02	....	1.40	....
San Francisco	Douglas Fir	.90*bef*	....	....	1.95*caf*
Montreal	Birch or Maple	.65	1.05*a*	.75	1.35*a*

Tr.—Treated; Untr.—Untreated. *a* Creosoted. *b* 6" x 8" x 8′6". *c* Empty cell. *d* Zinc. *e* Green. *f* At ships tackle.

CHEMICALS

Water, sewage treatment, road work, f.o.b. carlots, New York

Bleaching powder, in drums, f.o.b. works, per 100-lb.	$2.00-2.85
Chlorine cylinders, liquid, per lb. delivered	.0525
Calcium chloride, 77-80%, flaked, in 400-lb. drums or 100-lb. moisture proof bags, delivered, per ton	22.00-35.00
Silicate of soda, 52 deg., in drums, f.o.b. works, per 100 lb.	1.40
Soda ash, 58%, in paper bags, per 100 lb. dense	1.10
Sulphate of aluminum, commercial, in 100-lb. bags, per ton	23.00
Sulphate of copper, in bbl., per 100-lb.	4.75

STRUCTURAL CLAY BUILDING TILE, BRICK AND LIME—DELIVERED

	STRUCTURAL CLAY TILE — PARTITION — SCORED Per M. lots of 2,000 pieces or over,			STRUCTURAL CLAY TILE — LOAD BEARING — SCORED Per M. lots of 2,000 pieces or over,			BRICK Per M. in quantity.		LIME		
	3x12x12 in.	4x12x12 in.	8x12x12 in.	8x12x12 in.	10x12x12 in.	12x12x12 in.	Common backing	Straight hard	Per ton, Hydrated finishing	In paper Common hydrated	Carload lot Pulverized or lump
Atlanta	$90.00	$100.00	$185.00	$220.00	$230.00	$240.00	$12.50	$16.00	$24.00	$15.50	$15.50
Baltimore	74.00	80.00	165.00	190.00	240.00	290.00	13.00k	16.00k	18.50	14.50	2.50m
Birmingham	80.00	85.00	160.00	191.00	252.00	288.00	13.50	16.50	18.11	12.35	1.66lo
Boston	82.10a	87.60a	164.20a	186.10a	243.20a	277.90a	17.00i	20.00i	19.00	12.50	3.10lp
Chicago	68.10	72.60	135.90	185.70	234.90	268.10	11.00	12.00	16.40	14.40	12.20
Cincinnati	61.40	65.30	121.90	141.50	187.30	215.20	16.00	16.00	15.90	13.00	.....
Cleveland	54.50	58.00	109.00	130.50	175.50	200.50	16.00	16.00	15.00j	12.00j	2.75jm
Dallas	62.50	67.00	135.00	162.00	177.00	263.00	11.50i	13.50i	19.00	15.00	.95n
Denver	84.80	95.40	152.70	178.20	212.00	227.90	13.50	17.00	28.00j	17.00j	35.00j
Detroit	68.90	73.50	137.80	175.50	232.00	265.00e	15.70	17.00	13.50	11.75	12.75
Kansas City	64.50	66.50	86.00c	125.50	159.75	186.25	14.00	24.00	19.10	12.80	10.70
Los Angeles	73.50†r	89.50†r	128.00c†r	210.00†r	368.00†r	460.00†r	13.00	15.00	16.50	.....	17.50
Minneapolis	66.70	71.20	122.50	141.30	149.30	209.40	13.10	15.10g	21.00	16.00	19.00
Montreal	72.20a	77.50a	142.50at	76.00a	165.80a	248.70	20.75	28.00	23.50	17.00	1.75lo
New Orleans	72.00	72.00	135.00	162.00	210.00	260.00	14.00	.....	18.30	12.08	14.10
New York	87.00	93.00	128.00	193.30h	238.80h	295.60h	13.50	.....	20.00	14.00	18.00
Philadelphia	80.50	85.90	161.10	193.30	238.80	296.60	15.00s	18.00s	15.50q	9.55q	12.05q
Pittsburgh	58.40	62.40	116.85	124.00	153.00	193.75	17.00	25.00	17.90	15.40	2.55m
St. Louis	62.00	88.00	120.00	180.00	234.00	280.00	16.00	17.00	22.00	16.00	2.30lm
San Francisco	84.00	94.50	225.00	......	......	......	14.00	17.00	.55o	.40o	2.05m
Seattle	100.00	110.00	220.00	......	......	......	17.50f	17.50f	20.00s	20.00s	20.00s

† F.o.b. *a* Smooth. *b* Carload lots delivered to job. *c* 6 x 12 x 12 in. *d* Not load bearing. *e* 48 lb. tile. *f* Less $1.00, ½ cash 15 days, balance 30 days. *g* Selected common. *h* F.o.b. Perth Amboy, N. J. *i* 50c per M. off for cash. *j* LCL. *k* $1.00 discount if paid in 10 days. *l* Lump. *m* Per bbl., 180 lb. *n* Per sack 100 lb. *o* Per bbl., 200 lb. *p* 280 lb. bag. *q* 25-ton cars. *r* 5% discount 10 days. *s* 2% off cash. *t* 5½ x 8 x 12.

PAINT, ROOFING—F.O.B. CARLOAD LOTS

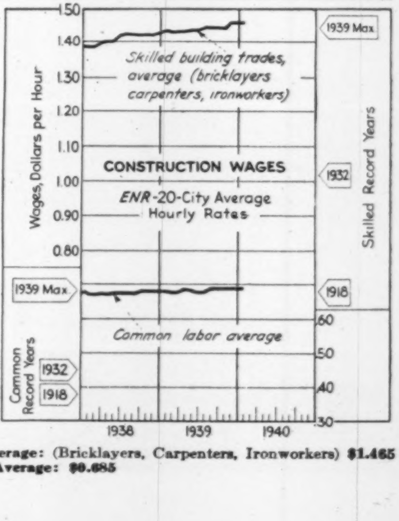
	RED LEAD Per 100 lb. in. 600-lb. (Approx.) bbl.	WHITE LEAD	READY-MIXED PAINT Per gal., drums			ROOFING SUPPLIES Carload lots f.o.b. factory				
	Dry a	Per 100 lb. in oil	Graphite b	Aluminum c	Ferric Oxide d	Rolls, slate surfaced, 85–90 lb., per sq.	Asphalt felt, per 100 lb.	Tar felt, per 100 lb.	Asphalt coating per gal.	Tar pitch 350 lb. bbl. per ton
Atlanta	$9.25	$13.125	$1.30	$2.25	$1.20	$1.71	$1.65	$1.65	$0.36	$26.00
Baltimore	9.00	12.75	1.70	2.45	1.95	2.20	2.75	2.75	.45	27.50
Birmingham	9.25	13.125	2.68	2.75	1.85	1.92	1.77	1.77	.45	27.00
Boston	9.00	12.75	1.70‡	2.20‡	1.75‡	1.70‡	1.80h‡	1.80h‡	.45‡	20.00‡
Chicago	9.00	12.75	1.96	2.63	1.68	1.45hf	1.53hf	1.53hf	.26f	21.00f
Cincinnati	9.00	12.75	1.65	2.85	1.55	2.40	2.39h	2.39h	.36	21.00
Cleveland	9.00	12.75	1.90	2.60	1.60	1.68	1.55h	1.55h	.35	21.00
Dallas	9.00	13.50	1.88	2.11	....	2.75h	2.60h	2.70h	.60	....
Denver	9.50	13.25	1.65	2.40	.17l	2.45	4.00	3.00	.35	18.00
Detroit	9.00	12.75	2.00	3.00	1.75	2.40	2.75	2.75	.35	27.50
Kansas City	9.00	12.875	2.15g	2.40g	1.67g	1.93	2.09	2.09	.25	25.00
Los Angeles	9.25	13.25	1.60	2.25	2.30	2.10	1.50	....	.45	....
Minneapolis	9.00	12.875	....	....	....	1.68i	1.55hi	1.55hi	.29	21.00
Montreal	9.25	9.00	2.25	2.80	2.35	2.53	1.68	1.78	.70	1.68k
New York	9.00	12.75	1.88	2.55	1.60	1.68	1.45h	1.45h	.23	24.00
Philadelphia	9.00	12.75	....	....	....	1.92e	1.99he	1.99he	.41e	21.00
Pittsburgh	9.00	12.75	1.05	1.95	.80	1.95	1.94h	1.94h	.34	26.00
St. Louis	9.00	12.75	1.90/2.00	2.60/2.85	1.60/2.00	1.50	1.45	1.45	.24	21.00
San Francisco	9.25	13.00	1.80	2.75	1.10/2.00	1.66	1.90	1.90	.325	20.50
Seattle	9.25	13.25	1.80	2.60	....	1.81	1.30/2.00	1.75	.35	28.00j

‡ Delivered. Note: Red lead in oil 50c. higher than white lead in oil. *a* Red lead prices change frequently due to pig lead price changes. *b* U. S. War Dept. Spec. 3–49A. *c* ASTM Spec. D266–31. *d* 80% minimum ferric oxide. *e* Subject to 25% discount. *f* Distributors' price to contractors. *g* 5 gal. cans. *h* Per roll, 65 lb. *i* Minneapolis and vicinity. *j* Asphalt pitch. *k* per 100 lb. *l* per lb.

SKILLED AND COMMON WAGE RATES—PER HOUR

	Bricklayers	Carpenters	Struct. Iron Workers	Hoisting Engineers	Plasterers	Common Labor Building	Common Labor Heavy Const.
Atlanta	$1.25	$1.00	$1.375	$1.00/1.25	$1.25	$0.40/.50	$0.40/.50
Baltimore	1.50	1.25	1.65	1.50	1.25	.5625	.5625
Birmingham	1.50	1.125	1.25	1.125	1.00	.30/.40a	.30/.40a
Boston	1.50	1.375	1.50	1.625	1.625	.60/.85	.60/.85
Chicago	1.70	1.625	1.70	1.70	1.70	1.025	1.025
Cincinnati	1.625	1.45	1.525	1.00/1.525	1.625	.60/.75	.60/.75
Cleveland	1.625	1.375	1.50	1.50/1.75	1.50	.90	.90
Dallas	1.50	1.00	1.25	1.00	1.50	.40/.50	.40/.50
Denver	1.65b	1.50b	1.43b	....	1.50b	.718b	.718b
Detroit	1.50	1.25	1.50	1.50	1.55	.60/.75	.60/.75
Kansas City	1.625	1.375	1.50	1.50	1.575	.85	.50
Los Angeles	1.25	1.10	1.375	1.375	1.50	.625	.625
Minneapolis	1.375	1.25d	1.50	1.40	1.50e	.85	.85
New Orleans	1.50	1.20	1.50	1.50	1.40	.40	.40
New York	1.90b	1.75b	1.925	2.00b	2.00c	1.031	.875/.95
Philadelphia	1.65b	1.25	1.65	1.50	1.565	.60	.60
Pittsburgh	1.75	1.50	1.50	1.25	1.75	.80	.70
St. Louis	1.50	1.25/1.50	1.75	1.75/2.00	1.58/1.75	.45/.875	.45/.875
San Francisco	1.75c	1.25f	1.50	1.50	1.60c	.81	.65
Seattle	1.60c	1.25	1.50c	1.50c	1.60c	.90c	.90c
Montreal	.80	.70	.75	.65	.80	.45	.40

a PWA. *b* 7 hr. day. *c* 6 hr. day. *d* 35 hr. wk. *e* 30 hr. wk. *f* Working under "stop-gap" agreement.



ENR Skilled Average: (Bricklayers, Carpenters, Ironworkers) $1.465
ENR Common Average: $0.685

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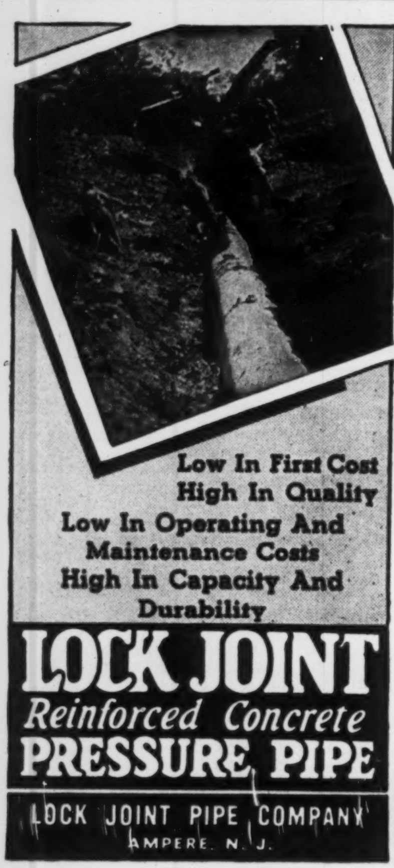
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(Continued from p. 72)

Superintendents Association, State Office Building, Albany, N. Y., Jan. 10-11.

Kansas Contractors Association, Kansas City, Mo., Jan. 11-12.

Louisiana Engineering Society, fifth annual meeting, St. Charles Hotel, New Orleans, Jan. 12-13.

Colorado Association of Highway Contractors, annual meeting, Denver, Colo., Jan. 13.

Engineering Congress, University of Colorado, Boulder, Colo., Jan. 18-19.

Annual Engineers Institute, North Carolina State College, Raleigh, N. C., Jan. 24-27.

Illinois Society of Engineers, Rockford, Ill., Jan. 25-27.

North Carolina Society of Engineers, annual meeting, Raleigh, Jan. 26.

American Society of Civil Engineers, North Carolina Section, Raleigh, Jan. 27.

Wyoming Engineering Society, 1940 Convention, Laramie, Feb. 2-3.

ELECTIONS AND MEETINGS

John M. Moltz was elected president of the Harrisburg Chapter, Pennsylvania Society of Professional Engineers, at its annual dinner meeting Dec. 18. Other officers named were: Ritchie Lawrie, Jr., vice-president; Russell S. Conrad, secretary; H. Hershey Miller, treasurer; Hubert C. Eicher, state director, and H. S. Mattimore and George H. Rahn, members of the executive board.

Gardner C. George, research engineer of the New York Power and Light Corp., is the new president of the Albany Society of Engineers, succeeding Frank J. Spath. Other new officers are: Arthur W. Harrington, first vice-president; John L. Harvey, second vice-president, J. Cotter Nash, third vice-president; Arthur H. Lamborn, librarian, and John W. Henry, secretary-treasurer.

The Associated General Contractors of Wyoming have opened an office at the Plains Hotel in Cheyenne. Robert M. Ashley of Billings is in charge as managing secretary.

Russell Forney, head of the Forney Machine Co., New Castle, Pa., was elected president of the Mahoning-Shenango Engineers Society at a dinner meeting of the society Dec. 11. Other officers are: James Beam, Uni-